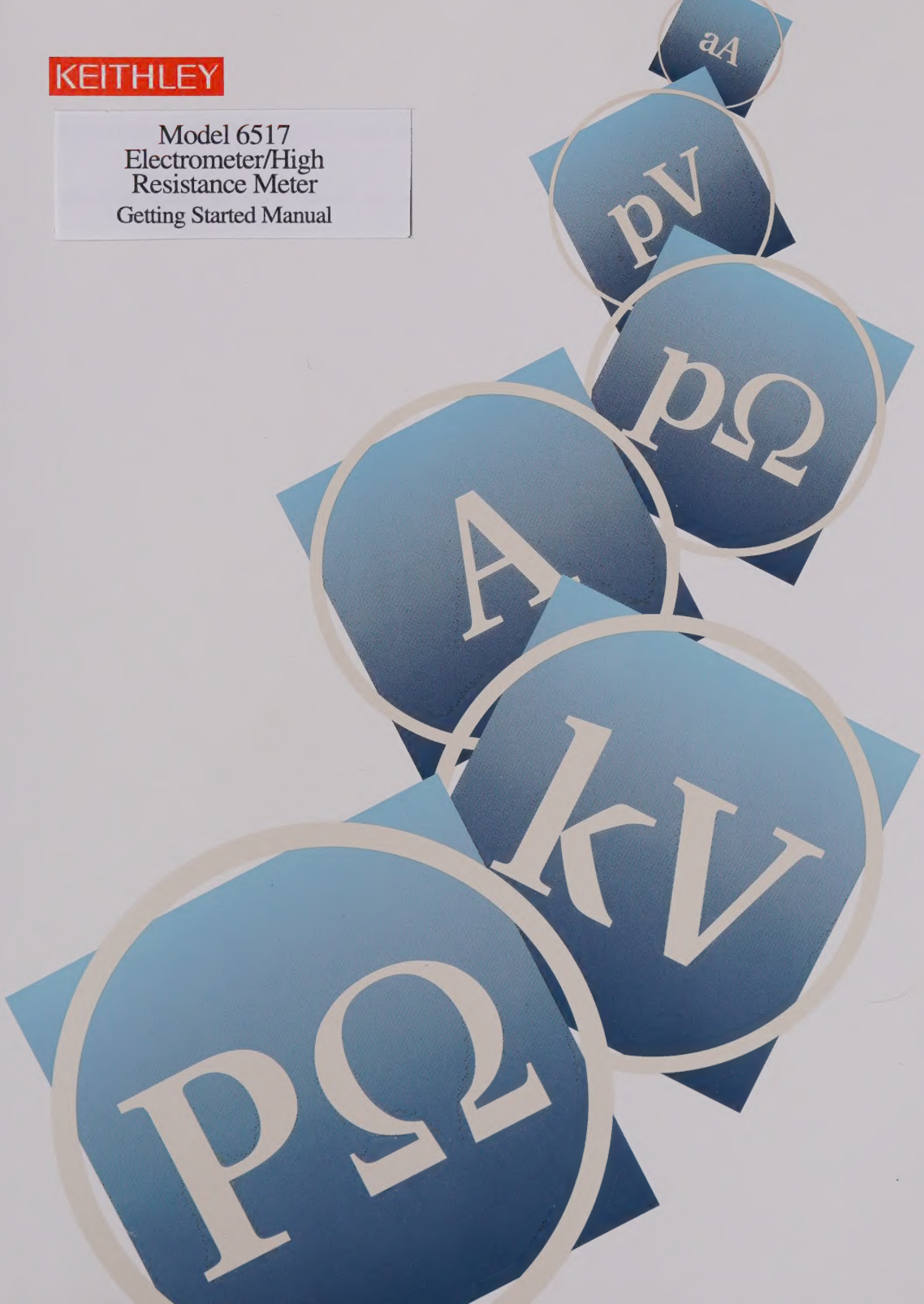
KEITHLEY

Model 6517 Electrometer/High Resistance Meter

Getting Started Manual



Model 6517 Electrometer/High Resistance Meter

Getting Started Manual

Contains Operating Information

KEITHLEY

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Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

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Model 6517 Electrometer/ High Resistance Meter Getting Started Manual

All references to the Model 6517 also apply to the Model 6517A.

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.
For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indieated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean the instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument.

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1
Front Panel Operation

Product overview

If you have any questions after reviewing this information, please contact your local Keithley representative, or call one of our Applications Engineers at **1-800-348-3735** (U.S. and Canada only). Worldwide phone numbers are listed in the front of this manual.

The Model 6517 is a 6½-digit electrometer/high resistance system with the following measurement capabilities:

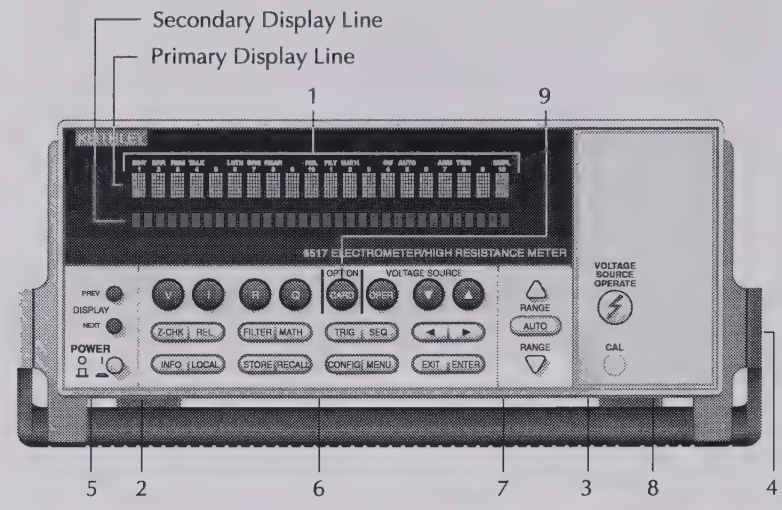
- DC voltage measurements from 10μV to 210V
- DC current measurements from 100aA to 21mA
- Charge measurements from 10fC to 2.1μC
- Resistance measurements from 10Ω to 210TΩ
- Surface resistivity measurements
- Volume resistivity measurements
- External temperature measurements from -25°C to 150°C using the supplied Model 6517-TP thermocouple
- Relative humidity measurements (0 to 100%) using the optional Model 6517-RH probe

Some additional capabilities of the Model 6517 include:

- Built-in V-Source — The 100V range provides up to 100V at 10mA, while the 1000V range provides up to 1000V at 1mA
- Data storage
- Single button zeroing (REL)
- Built-in math functions
- Filtering; averaging and median
- Built-in test sequences
- Remote operation using the IEEE-488 (GPIB) bus or the RS-232 interface
- Model 617 emulation using the DDC (device-dependent command) programming language mode
- Scan (measure) channels of an external scanner (e.g., Model 7001 or 7002)
- Scan (measure) channels of an internal scanner card (e.g., Model 6521 or 6522) installed in the option slot

The Model 6517 front and rear panel overviews (Figures 1 and 2) include important abbreviated information that should be reviewed before operating the instrument.

Figure 1
Model 6517 front panel overview



1 ANNUNCIATORS

ERR	Questionable reading
REM	In remote
TALK	Addressed to talk
LSTN	Addressed to listen
SRQ	Service Request
REL	Relative reading displayed
FILT	Digital filter enabled
MATH	Math calculation enabled
AUTO	Autoranging enabled
ARM	Trigger armed; not in idle
*(asterisk)	Reading being stored

2 FUNCTION KEYS Select measurement function; volts (V), amps (I), resistivity (R) or coulombs (Q)

3 RANGE KEYS

▲	Moves to higher range; increments digit
▼	Moves to lower range; decrements digit
AUTO	Enables/disables autorange

4 HANDLE (not shown) Pull out and rotate to desired position.

5 DISPLAY KEYS PREV/NEXT Scroll through multiple displays of a function

6 OPERATION KEYS

Z-CHK	Enables/disables zero check. Enable zero check before changing functions.
REL	Enables/disables relative reading
FILTER	Displays digital filter status for present function and toggles filter on/off
MATH	Displays math calculation and toggles math on/off if configured
TRIG	Triggers unit
SEQ	Performs selected test sequence
◄ and ►	Moves cursor among data entry digits, menu selections, and information displays
INFO	Shows context-sensitive information about the present display
LOCAL	Cancels remote operation
STORE	Enables data storage
RECALL	Displays reading data (reading, number, time). Use PREV/NEXT DISPLAY for maximum, minimum average, standard deviation.
CONFIG	Configures functions and operations
MENU	Saves/restores instrument conditions; sets up communications; performs calibration and self-tests; defines limits, digital output, and other miscellaneous operations (see Table 2)
EXIT	Cancels selection, moves back within menu structure
ENTER	Holds reading, enters selection, moves down within menu structure

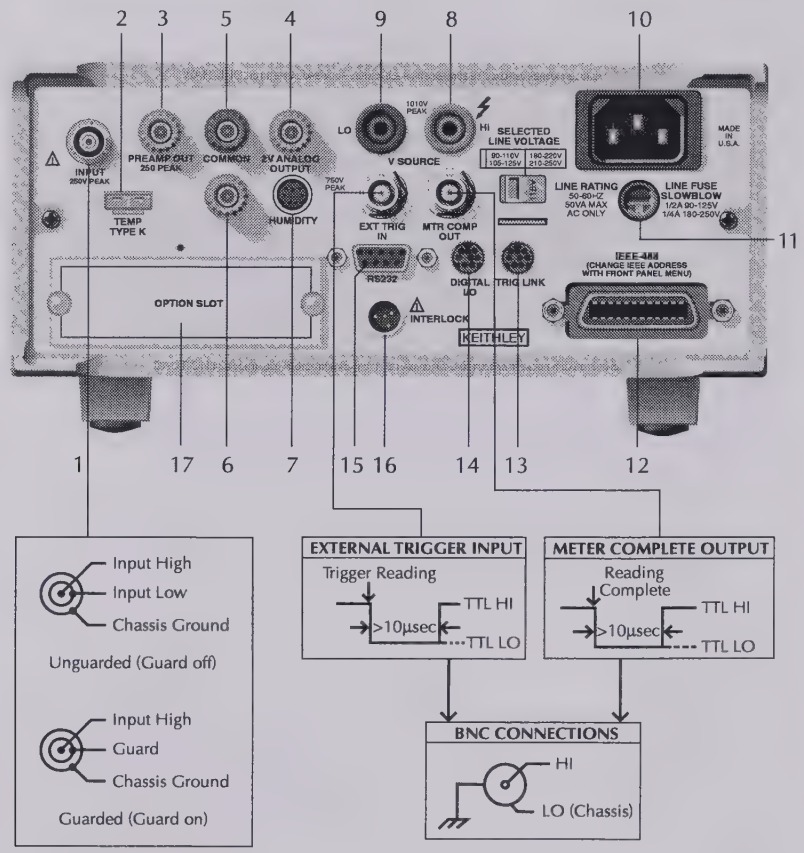
7 VOLTAGE SOURCE KEYS

OPER	Toggles V-source between operate and standby
▲ and ▼	Adjusts V-source value

8 VOLTAGE SOURCE OPERATE Indicator on when in operate, off when in standby

9 OPTION CARD KEY Use to program and operate an installed option. Also used to scan external scanner channels.

Figure 2
Model 6517 rear panel overview



1 **INPUT CONNECTOR (see Figure 2)**
Unguarded Configuration — Disable GUARD for amps, ohms, coulombs and unguarded volts measurements.
Guarded Configuration — Enable GUARD for guarded volts measurements.

2 **TEMP TYPE K** Connect the Model 6517-TP type K thermocouple for temperature measurements.

3 **PREAMP OUT** Follows the signal amplitude applied to the INPUT terminal. With GUARD on, PREAMP OUT is internally connected to the inner shell of the INPUT triax connector to configure the input for guarded volts measurements. Referenced to COMMON. See the Model 6517 User's Manual for more information.

4 **2V OUTPUT** Binding post provides a scaled 0 to 2V output that is referenced to COMMON. Typically connected to a measuring device such as a chart recorder. See the Model 6517 User's Manual for more information.

5 **COMMON** Binding post that is internally connected to INPUT low through a 0.6Ω resistor.

6 **CHASSIS GROUND** Binding post that connects the chassis to ground through the power line cord. COMMON can be connected to chassis ground by installing the ground link. For floating measurements, make sure the ground link connection between COMMON and Chassis Ground is open.

7 **HUMIDITY** Connect the optional Model 6517-RH probe for relative humidity measurements.

8 **V-SOURCE HI and LO** Banana jacks for the voltage source.

9 **LINE VOLTAGE SWITCH** Two-position slide switch configures instrument for available line power voltage. A 90 to 125V line voltage requires the 115V setting, while a 180 to 250V line voltage requires the 230V setting.

10 **POWER LINE INPUT** Connect to power line (50 or 60Hz) grounded outlet using 3-wire power cord.

11 **LINE FUSE** For the 115V line voltage setting, use a ½A, 250V, slow blow, 5×20mm fuse. For the 230V setting, use a ¼A, 250V, slow blow, 5×20mm fuse.

12 **IEEE-488 CONNECTOR** Connects the instrument to the IEEE-488 (GPIB) bus. Use shielded IEEE-488 cables.

13 **TRIG LINK** An 8-pin micro DIN connector for sending and receiving trigger pulses to and from other instruments.

14 **DIGITAL I/O** An 8-pin micro DIN connector for the four TTL-compatible digital output lines.

15 **RS-232** DB-9 connector for the RS-232 interface. Use a standard RS-232 cable.

16 **INTERLOCK** Connects the safety interlock to the Model 8009 Resistivity Test Fixture or the Model 8002A High Resistance Test Fixture using the appropriate cable.

17 **OPTION SLOT** An option card, such as the Model 6521 or 6522 scanner card, installs in this slot.

Display

As shown in the Model 6517 front panel overview (Figure 1), the front panel has three lines of display information: the primary display line, the secondary display line, and annunciators.

- Primary Display Line: The top line displays readings along with units. It can also display measurement type, "hold", math operating type, channel number, menu headings and messages. Error and status messages are listed in Section 2 of the User's Manual.
- Secondary Display Line: The bottom line displays the range, V-Source value, menu items, messages and multiple displays (see Measurement Options section of this manual). Longer text strings are indicated by arrows on either end of the display line. Use the cursor keys (◄ and ►) to display the additional information.

Power-up

WARNING ***Before turning on the Model 6517, make sure it is connected to a grounded power receptacle using the supplied power cord or the equivalent. Failure to properly ground the unit creates a shock hazard that could result in injury or death.***

Use the front panel POWER switch to turn power on and off.

During power-up, the Model 6517 performs self-tests on its memory elements. If a failure occurs, the instrument momentarily displays an error message and turns on the ERR annunciator. If the instrument passes the self-tests, the firmware revision level, and bus interface information are displayed.

For complete information on the power-up sequence, see Section 2 in the User's Manual.

Warm-up

The instrument is ready for use as soon as the power-up sequence is completed. However, to achieve rated accuracy, allow the instrument to warm up for one hour. If the instrument has been subjected to extreme temperatures, allow additional time to allow internal temperatures to stabilize.

Bench defaults

The Model 6517 can save ten user setups in non-volatile memory. You can select one of the user setups as the power-on default, or have the instrument power up to either of the two factory defaults (optimized for "BENCH" or "GPIB" operation).

Since the basic measurement procedures in this manual assume the BENCH defaults, reset the instrument from the SAVESETUP item of the MAIN MENU by performing the following steps:

1. Press the MENU key to display the main menu:

   MAIN MENU
   SAVESETUP COMMUNICATION CAL ▶
   ◀ TEST LIMITS STATUS-MSG GENERAL

2. If the SAVESETUP option is not blinking, press the ◀ key until it is blinking and then press ENTER to view the setup menu:

   SETUP MENU
   SAVE RESTORE POWERON RESET

3. Select the RESET option and press ENTER to view the reset menu:

   RESET ORIGINAL DFLTS
   BENCH GPIB

4. Select the BENCH option and press ENTER. The following message is displayed:

   RESETTING INSTRUMENT
   Enter to confirm; EXIT to abort

5. Press ENTER to confirm. The display will go to the volts function with auto-range disabled and zero check enabled.

Other BENCH default settings for each function include:

- Triggers — Continuous measurements.
- Measurement speed (integration time) — Normal, 1 power line cycle.
- Digital filter — Enabled, averaging, 10 readings.
- Median filter — Enabled, rank 1.
- Display resolution — 5½ digits.

Note: See "Menus" in the Measurement Options section of this manual for details on navigating the Main Menu.

Changing functions

To avoid erratic operation, always enable zero check ("ZeroCheck" displayed) before selecting one of the other measurement functions (V, I, R or Q). The Z-CHK key controls zero check. See "Zero Check" in Section 2 for more information on the zero check feature.

Voltage measurements

Assuming "BENCH" reset conditions, the basic procedure is as follows:

1. With zero check enabled ("ZeroCheck" displayed), select the volts function by pressing V. The Z-CHK key is used to enable/disable zero check.
2. Enable or disable guard as needed. See "Guarding" at the end of this procedure.

NOTE *With guard enabled (ON), the "Grd" message is displayed. However, if zero correct is already enabled ("ZCor" displayed), then "Grd" will not be displayed.*

3. To achieve optimum accuracy for low voltage measurements, zero correct the Model 6517. To do this, use the RANGE ▼ key to select the lowest measurement range (2V) and press REL. With zero correct enabled, the REL indicator is on.

NOTE *With zero correct enabled, the "ZCor" message is displayed. However, if guard is already enabled ("Grd" displayed), then "ZCor" will not be displayed.*

4. Select a measurement range or use autoranging.
   A. To automatically select the most sensitive range, enable autorange. The AUTO key enables and disables autorange. When enabled, the AUTO annunciator is on.
   B. For manual ranging, use the RANGE ▲ and ▼ keys to select a measurement range consistent with the expected voltage.
5. Connect the test cable(s) to the voltage to be measured. Figure 3A shows connections for unguarded measurements, and Figure 3B shows connections for guarded measurements.

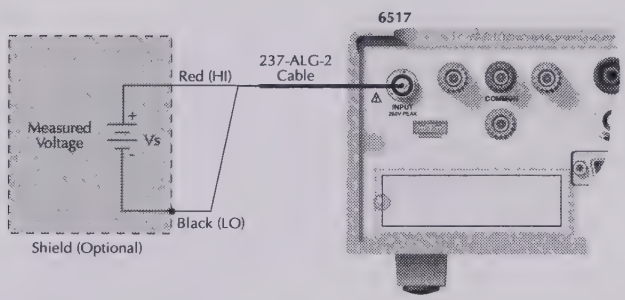
WARNING ***Hazardous voltage may be present on the inner shield of the triax cable when GUARD is on. A safety shield connected to safety earth ground (as shown in Figure 3B) should be used for voltage measurements at or above 30V.***

CAUTION ***Do not apply more than 250V peak (DC to 60Hz) to the input or instrument damage may occur.***

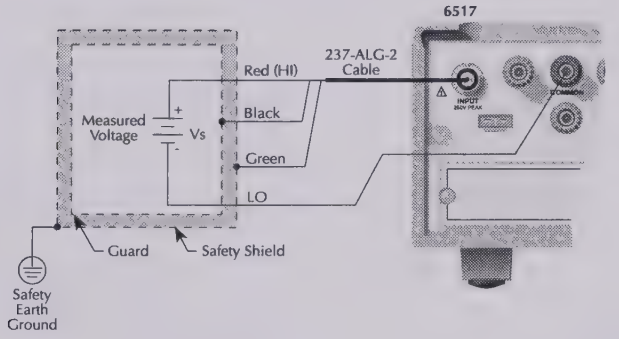
6. Press Z-CHK to disable zero check and take a reading from the display.

Figure 3
Voltage measurements

A. Unguarded (GUARD off)



B. Guarded (GUARD on)



Guarding

Guarding should be used for high impedance ($\geq 10^9\Omega$) voltage measurements and for voltage measurements that use long input cables. In a high impedance circuit, guarding greatly reduces leakage currents. When using long input cables, guarding cancels the effects of cable capacitance that can significantly slow down the measurement response time.

When GUARD is enabled, the INPUT triax connector is reconfigured to apply the guard potential to the inner shell of the INPUT triax connector. With this configuration, the COMMON banana jack is used for input low. Figure 3 shows both the guarded and unguarded configuration of the INPUT connector.

Perform the following steps to enable or disable guard:

1. Press CONFIG and then V to display the volts configuration menu.
2. Use the ◄ and ► keys to place the cursor (blinking menu item) on GUARD and press ENTER.
3. Place the cursor on the desired selection (OFF to disable or ON to enable) and press ENTER.
4. Use the EXIT key to back out of the menu.

Current measurements

Assuming "BENCH" reset conditions, the basic procedure is as follows:

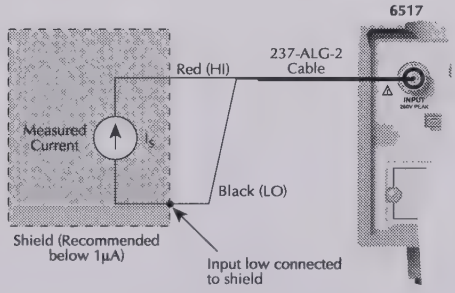
1. With zero check enabled ("ZeroCheck" displayed), select the amps function by pressing I. The Z-CHK key is used to enable/disable zero check.
2. To achieve optimum accuracy for low current measurements, zero correct the Model 6517. To do this, use the RANGE ▼ key to select the lowest measurement range (20pA) and press REL. With zero correct enabled, the REL indicator is on, and the message "ZCor" is displayed.
3. Select a measurement range or use autoranging:
   A. To automatically select the most sensitive range, enable autorange. The AUTO key enables and disables autorange. When enabled, the AUTO annunciator is on.
   B. For manual ranging, use the RANGE ▲ and ▼ keys to select a measurement range consistent with the expected current.
4. Connect the instrument to the current to be measured as shown in Figure 4.

CAUTION ***Do not apply more than 250V peak (DC to 60Hz; 10 seconds per minute maximum on mA ranges), or instrument damage may occur.***

5. Press Z-CHK to disable zero check and take a reading from the display.

NOTE *To disable zero correct, enable zero check and then press REL.*

Figure 4
Current measurements



Resistance measurements

NOTE *Accurate high resistance measurements require the use of a low-leakage test fixture, such as the Model 8002A.*

The following procedure requires "BENCH" reset conditions. See "Bench defaults" to reset the instrument.

1. With zero check enabled ("ZeroCheck" displayed), select the ohms function by pressing R.
2. Select Auto V-Source ohms. In this mode, the V-Source is automatically set to a voltage (nominally 40V or 400V) that optimizes measurement accuracy. See "Auto V-Source" to select Auto V-Source ohms.

NOTE *"BENCH" reset conditions selects Manual V-Source ohms. In this mode, you must manually set the V-Source level for the measurement. See "Voltage Source" in Section 2 for details on using the V-Source.*

WARNING ***Selecting Auto V-Source ohms may set the V-Source to 400V.***

3. Select a measurement range or use autoranging:
   A. To automatically select the most sensitive range, enable autorange. The AUTO key enables and disables autorange. When enabled, the AUTO annunciator is on.
   B. For manual ranging, use the RANGE ▲ and ▼ keys to select a measurement range consistent with the expected resistance.
4. Connect the Model 6517 to the test fixture. Generic connections are shown in Figure 5A. Note that this connection scheme requires that ammeter LO be internally connected to V-Source LO. See "Configuring V-Source" in Section 2 to control this internal LO-to-LO connection. If using the Model 8002A test fixture, refer to Figure 5B.

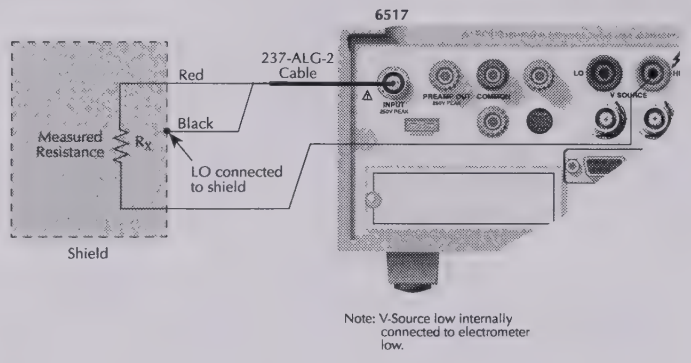
NOTE *For optimum accuracy, leakage currents in the test fixture can be cancelled by performing REL on the current component of the measurement. To cancel leakage current, perform the procedure in "Amps Rel".*

5. Disable zero check by pressing Z-CHK and press OPER to source voltage to the test fixture DUT.
6. Take a reading from the display.
7. Place the V-Source in standby when finished by again pressing OPER.

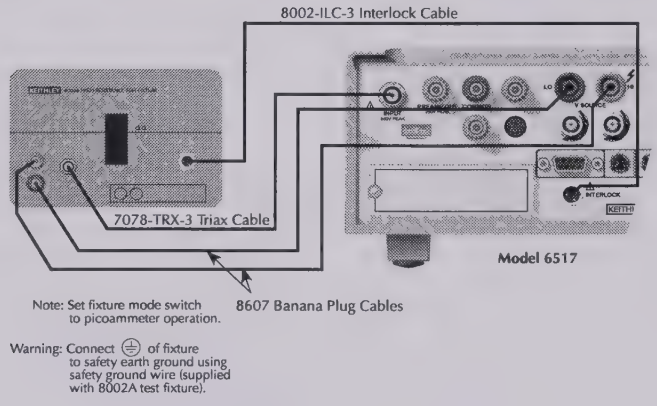
WARNING ***Place the V-Source in standby before making or breaking connections to the test fixture or DUT.***

Figure 5
Resistance measurements

A. Generic connections



B. Connections using 8002A test fixture



Auto V-Source

Auto V-Source should be used to achieve optimum accuracy for ohms measurements. With Auto V-Source selected, the V-Source is automatically set for either 40V or 400V. For the 2MΩ through 200GΩ ranges, the V-Source is set to 40V. For the 2TΩ through 200TΩ ranges, a 400V test voltage is used. With Manual V-Source selected, you can manually set the voltage level of the V-Source.

Perform the following steps to select the V-Source mode for the ohms function:

1. Press CONFIG and then R to display the ohms configuration menu.
2. Use the ◄ and ► keys to place the cursor (blinking menu item) on VSOURCE and press ENTER.
3. Place the cursor on AUTO (Auto V-Source ohms) or on MANUAL (Manual V-Source ohms), and press ENTER.
4. Use the EXIT key to back out of the menu.

Amps Rel

Amps Rel is used to cancel leakage current in a test fixture for ohms measurements. Perform the following steps:

NOTE *This procedure assumes that steps 1 through 4 of the Resistance Measurement procedure have been performed.*

1. With the V-Source in standby, remove the DUT from the test fixture.
2. Select the amps (I) function and disable zero check.
3. Place the V-Source in operate by pressing OPER. The VOLTAGE SOURCE OPERATE indicator is on when in operate.
4. Select the lowest possible measurement range to display the leakage current in the test fixture.
5. Enable relative (REL annunciator on) by pressing REL. This zeroes the display, cancelling the leakage current reading.
6. Press OPER to place the V-Source in standby and enable zero check.
7. Perform the following steps to establish the amps Rel value for the ohms function.
   A. Press CONFIG and then R to display the ohms configuration menu.
   B. Use the ◄ and ► keys, place the cursor (blinking menu item) on AMPSREL and press ENTER.
   C. Place the cursor on ENABLED and press ENTER to use the amps Rel value for the ohms measurement.
   D. Use the EXIT key to back out of the menu.
8. Re-install the DUT in the test fixture.
9. Select the ohms function (R) and proceed to step 5 of the Resistance Measurement procedure.

Resistivity measurements

NOTE *The following procedure to measure resistivity (surface or volume) requires the use of the Keithley Model 8009 Resistivity Test Fixture. Refer to the Model 8009 Instruction Manual for details on using the test fixture.*

The following procedure requires "BENCH" reset conditions. See "Bench defaults" to reset the instrument.

1. With zero check enabled ("ZeroCheck" displayed), select the ohms function by pressing R.
2. Select Auto V-Source ohms. In this mode, the V-Source is automatically set to a voltage (nominally 40V or 400V) that optimizes measurement accuracy. See "Auto V-Source" located under "Resistance Measurements" to select Auto V-Source ohms.

NOTE *"BENCH" reset conditions selects Manual V-Source ohms. In this mode, you must manually set the V-Source level for the measurement. See "Voltage Source" for details on using the V-Source.*

WARNING ***Selecting Auto V-Source ohms may set the V-Source to 400V.***

3. Select a measurement range or use autoranging:
   A. To automatically select the most sensitive range, enable autorange. The AUTO key enables and disables autorange. When enabled, the AUTO annunciator is on.
   B. For manual ranging, use the RANGE ▲ and ▼ keys to select a measurement range consistent with the expected resistance.
4. Connect the Model 6517 to the Model 8009 test fixture as shown in Figure 6, and set the switch on the test fixture to the desired measurement type (Surface or Volume).
5. Select the resistivity measurement mode as follows:
   A. Press the CONFIG and then R to display the ohms configuration menu.
   B. Use the ◄ and ► keys to place the cursor (blinking menu item) on MEAS-TYPE and press ENTER.
   C. Place the cursor on RESISTIVITY and press ENTER.

NOTE *The Model 6517 senses the switch position (surface or volume) on the Model 8009 through the interlock cable, and automatically configures the instrument for that measurement type.*

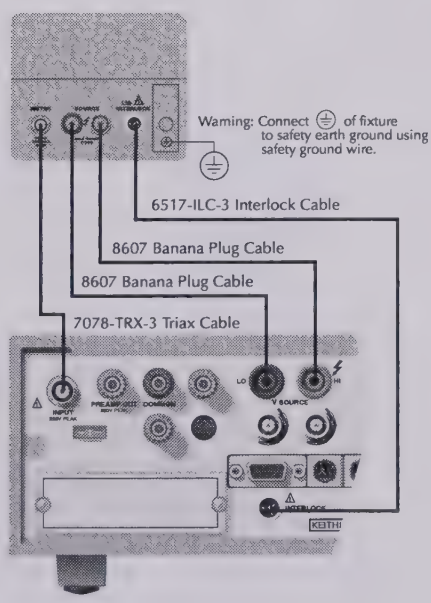
D. Cursor position (SURFACE or VOLUME menu item blinking) indicates the selected measurement type:
   - SURFACE — If Surface is the selected measurement type, you do not have to proceed any further into the menu structure. Use the EXIT key to exit from the menu.
   - VOLUME — If Volume is the selected measurement type, proceed as follows to specify the thickness of the sample:

   a. With the cursor on VOLUME, press ENTER to display the parameters menu for volume.
   b. Place the cursor on THICKNESS and press ENTER. The present thickness parameter for the sample will be displayed.
   c. Use the cursor keys (◀ and ▶) and the RANGE ▲ and ▼ keys to specify the thickness (in millimeters) of the sample, and then press ENTER.
   d. Use the EXIT key to back out of the menu structure.

6. Disable zero check by pressing Z-CHK.
7. Press OPER to source voltage to the DUT and, after an appropriate electrification time, take a reading from the display. Typically, an electrification time of 60 seconds is used.
8. Place the V-Source in standby when finished by again pressing OPER.

WARNING ***Place the V-Source in standby before making or breaking connections to the test fixture or DUT.***

Figure 6
Resistivity measurements


Warning: Connect ⏚ of fixture to safety earth ground using safety ground wire.
6517-ILC-3 Interlock Cable
8607 Banana Plug Cable
8607 Banana Plug Cable
7078-TRX-3 Triax Cable
V SOURCE
KEITHLEY

Charge measurements

Assuming "BENCH" reset conditions, the basic procedure is as follows:

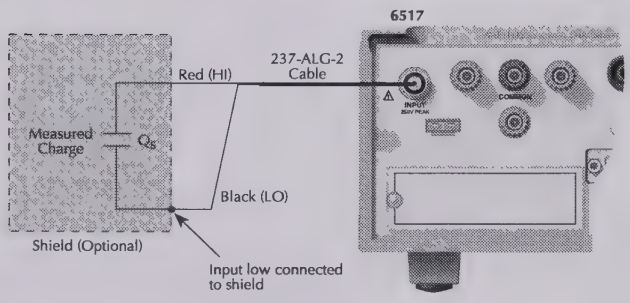
1. With zero check enabled ("ZeroCheck" displayed), select the coulombs function by pressing Q.
2. Select a measurement range or use autoranging:
   A. To automatically select the most sensitive range, enable autorange. The AUTO key enables and disables autorange. When enabled, the AUTO annunciator is on.
   B. For manual ranging, use the RANGE ▲ and ▼ keys to select a measurement range consistent with the expected charge reading.
3. Connect the test cable (see Figure 7) to the input of the Model 6517 and, with the input open, disable zero check. If needed, press REL to zero the display.
4. Connect the instrument to the charge to be measured as shown in Figure 7.

CAUTION ***Do not apply more than 250V peak (DC to 60Hz) or instrument damage may occur.***

5. Take a reading from the display.

NOTE *The reading can be reset to zero by enabling zero check. If you wish to have the reading reset to zero when a specified charge level is reached, enable Auto Discharge as explained in the following paragraph.*

Figure 7
Charge measurements



Auto discharge

When enabled, Auto Discharge is used to automatically reset the charge reading to zero when the specified charge level is reached. After the integrator resets, the charge measurement process simply restarts at zero. Perform the following steps to enable or disable Auto Discharge.

1. Press the CONFIG and then Q to display the coulombs configuration menu.
2. Use the ◄ and ► keys to place the cursor (blinking menu item) on AUTO-DISCHARGE and press ENTER.
3. Perform step A to enable Auto Discharge or perform step B to disable it:
   A. Enable Auto Discharge — Place the cursor on ON nad press ENTER to display the present discharge level. Use the ◄ and ► keys, and the RANGE ▲ and ▼ keys to set a different discharge level and press ENTER.
   B. Disable Auto Discharge — Place the cursor on OFF and press ENTER.
4. Use the EXIT key to exit from the menu.

External temperature and relative humidity measurements

The Model 6517 can make external temperature measurements from -25°C to 150°C using the Model 6517-TP type K thermocouple (which is a supplied accessory).

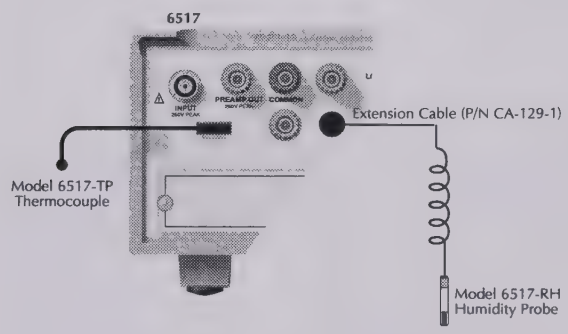
The Model 6517 can make relative humidity measurements (0 to 100%) using the Model 6517-RH humidity probe (which is available as an option).

Connections

The Models 6517-TP (thermocouple) and 6517-RH (humidity probe) connect to the rear panel connectors labeled "TEMP TYPE K" and "HUMIDITY" as shown in Figure 8.

NOTE *It is recommended that the thermocouple junction of the Model 6517-TP be electrically insulated from ground and voltage potentials. Erroneous reading will result if the thermocouple comes in contact with ground or a voltage potential.*

Figure 8
External temperature and humidity



Measurement control

BENCH reset disables temperature and humidity measurements. These measurements can be enabled from the front panel as follows:

1. Press MENU to display the main menu.
2. Use the ◄ and ► keys to place the cursor (blinking menu item) on GENERAL and press ENTER to display the menu items of the general menu.
3. Place the cursor on A/D-CONTROLS and press ENTER to display the A/D controls menu.
4. Place the cursor on DATA-STAMP and press ENTER. The present control state for temperature and humidity will be displayed. OFF indicates that the measurement is disabled, while ON indicates that the measurement is enabled.
5. To change the control state for temperature and/or humidity, place the cursor on the appropriate menu item and use the RANGE ▲ and ▼ keys to toggle the control state. With the desired states for temperature and humidity displayed (ON or OFF), press ENTER.
6. Use the EXIT key to back out of the menu.

Temperature units

All temperature readings by the Model 6517 can be displayed in °C, °F or K. BENCH reset selects °C measurement units. Perform the following steps to change units:

1. Press MENU to display the main menu.
2. Use the ◄ and ► keys to place the cursor (blinking menu item) on GENERAL and press ENTER to display the menu items of the general menu.
3. Place the cursor on DISPLAY and press ENTER to display the SET READING DISPLAY menu.
4. Place the cursor on TEMP-UNITS and press ENTER. The blinking cursor indicates the present temperature units selection.
5. To change temperature units, place the cursor on the desired selection (°C, K or °F) and press ENTER.
6. Use the EXIT key to back out of the menu.

Display reading options

Temperature and humidity readings are available as multiple (NEXT) displays. Using multiple displays, temperature and humidity readings can accompany each normal A/D measurement, and they can be included as data storage elements for each reading stored in he buffer. See "Multiple Displays" in Section 2 of this manual.

External temperature and humidity are selected as data store elements from the data store configuration menu. See "Buffer (Data Store)" in Section 2.

2
Measurement Options

This section describes the details of making measurements. Configuration options, triggers, reading storage, and scanning are just a few of the topics discussed. You will find this information useful whether operating the Model 6517 from the front panel or IEEE-488 bus.

Multiple displays

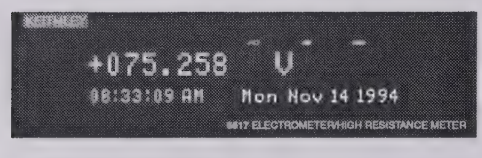
Each measurement function and some operations provide "multiple displays" by using the bottom line of the front panel. These multiple displays provide multiple type measurements, show a reading in a different form, or give additional information about the reading.

Multiple displays are summarized in this section. All the multiple displays are shown in Table 1.

The NEXT and PREV (previous) DISPLAY keys scroll through the multiple displays for the selected function or operation. The multiple display mode can be cancelled by pressing and holding in either key.

Table 1
Multiple displays by function

Function	Next display
All	Time, day and date Bar graph Zero-centered bar graph Maximum and minimum values Relative and actual values Calculated and actual values Limits bar graph Relative humidity and external temperature
Ohms (R)	Source (V) and measure (I) values.
Buffer	Relative humidity and external temperature, V-Source value, maximum reading, minimum reading, average reading, standard deviation, and print buffer data.

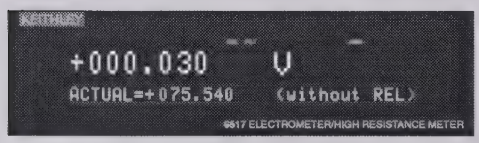


Time, Day and Date — This display provides the time, day of week, and the date. The time, date and format (12-hour or 24-hour) are set from the CLOCK option of the GENERAL MENU (see main Menu).

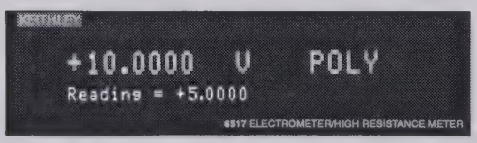
Bar Graph — The bar graph is a graphical representation of the reading with zero at the left end. Each full segment of the bar represents approximately 4% of the range limit.

Zero-centered Bar Graph — The zero-centered bar graph is a graphical representation of the reading using plus/minus limits with zero in the center. Each full segment represents 10% of the limit.

Maximum and Minimum — This display shows the maximum and minimum readings that have occurred since the display was entered. Maximum and minimum values are reset by pressing the present function key or by leaving the display.



Relative and Actual — This display is used with the rel (relative) feature. While the top line shows the result of the rel operation, the bottom line shows the actual (raw) reading.

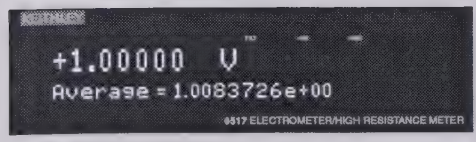


Calculated and Actual — This display is used with a math calculation. While the top line provides the result of the math calculation, the bottom line provides the raw reading.

Limits — This display provides the result of the limit test. The graphical representation of the reading is shown on a zero-centered bar graph. If the reading is between the specified high and low limits, the PASS message is displayed. If the reading is outside of the limits, the FAIL message is displayed. Limits are set and enabled from the LIMITS option of the Main Menu.

Relative humidity and external temperature — This display is used to display the relative humidity and external temperature readings. Note that the appropriate option has to be connected and enabled as explained in Section 1 of this manual.

Measure/source — This display is used to display the measured current and the V-Source level for ohms measurements.



Buffer — When in RECALL, there are seven displays for buffer readings:

Relative humidity (RH) and external temperature (ET).
V-Source value.
Maximum reading (shown at left).
Minimum reading.
Average reading (shown at left).
Standard deviation.
Print buffer data.

Menus

There are two basic menu structures used by the Model 6517: the main menu and the CONFIGure menus. The main menu accesses items for which there are no dedicated keys; the CONFIGure menus configure measurement functions and other instrument operations.

Table 2 summarizes main menu selections. Tables 3 and 4 show configuration settings for the measurement functions and instrument operations.

Table 2
Summary of main menu

Option	Description
SAVESETUP	Save and restore setups stored in memory, set power-on defaults, and return unit to default conditions.
COMMUNICATION	Select and configure interface (GPIB or RS-232).
CAL	Calibrate the Model 6517 (see Calibration Manual), perform offset adjustments and check calibration date.
TEST	Perform self-tests (see Repair Manual).
LIMITS	Configure unit to perform limit tests.
STATUS-MSG	Enable/disable status message mode.
GENERAL	Control output lines of digital output port, check serial number of unit and firmware revision levels, control line-sync, limit control and data stamp, configure timestamp, set reading display and set real-time clock.

Table 3
Configuration settings for each measurement function

Function	Speed	Filter	Reso-lution	Autorange limits	Damping	Guard	External feedback	Amps rel	Meas type*	V-Source**	Auto discharge
Volts	•	•	•	•		•	•				
Amps	•	•	•	•	•						
Ohms	•	•	•	•	•			•	•	•	
Coulombs	•	•	•	•							•

*Resistance or resistivity.
**Auto or manual.

Table 4
Configuration settings for instrument operations

Option	Description
CONFIG REL	Set rel (relative) value and enable.
CONFIG FILTER	Select and configure averaging and median filters.
CONFIG MATH	Select and configure math calculation: polynomial, percent, percent deviation, ratio or log10.
CONFIG TRIG	Select and configure basic or advanced trigger model.
CONFIG SEQ	Select and configure test sequence.
CONFIG STORE	Configure data store: set count, control, timestamp, elements and display, and clear buffer.
CONFIG VOLTAGE SOURCE*	Configure V-Source: range, V-limit, resistive I-limit and meter connect.
CONFIG CARD	Select and configure internal or external scanning.
CONFIG NEXT	Change the scale for the zero-center bar graph.

*To access the V-Source menu, press CONFIG and then any one of the VOLTAGE SOURCE keys: OPER, ▲ or ▼.

Navigating menus

Use the following rules to navigate through the menu structures. Table 5 summarizes the front panel keys used for navigation.

1. From the instrument's normal state of displaying readings, you can:
   - View a configuration menu by pressing CONFIG and then the desired function or operation key (V, TRIG, etc.).
   - View the top level of the main menu by pressing the MENU key.
2. The unit is returned to the normal reading display by:
   - Pressing EXIT or MENU from the top level of the main menu.
   - Pressing EXIT from the top level of a configuration menu.
   - Pressing a measurement function key from within a menu.
3. Pressing the ENTER key selects an item and, if further definition is needed, moves down within the menu structure. Pressing the EXIT key backs up within a menu structure.
4. The cursor position is denoted by a blinking menu item or parameter. The cursor is moved from one item to the next using the cursor keys (◀ and ▶). To select an item, highlight it with the cursor, then press ENTER.
5. A displayed arrow (◀ and ▶) on the bottom line indicates there is more information or additional menu items to select from. When " ◀ " is displayed, use the ◀ cursor key. The cursor keys have an auto-repeat feature.
6. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the RANGE ▲ or ▼ keys to increment or decrement the digit.
7. A change is only executed when the ENTER key is pressed. Entering an invalid parameter generates an error, and the entry is ignored. Changes are also ignored if an EXIT is performed.
8. The INFO key can be used anywhere in a menu to display helpful information messages concerning operation. To cancel an information message and remain in the menu, press INFO a second time, EXIT, or ENTER. Pressing a function key cancels INFO and a menu, and returns the instrument to a reading display.

Table 5
Menu summary

Action	Description
CONFIG-(function)	Press the CONFIG key, then a function key (e.g., V) to view the top level of a function configuration menu.
MENU	Press the MENU key to view the top level of the main menu. The operations that have no corresponding key are included in the main menu.
◄ or ►	Use the cursor keys to move the highlighted cursor among menu selections, or the digits of a parameter value, or change channels on the scanner.
RANGE ▲ RANGE ▼	Use the RANGE keys to increment and decrement digits of a parameter value.
ENTER	Accepts menu selection or data entry.
EXIT	Cancels changes menu selection. Also returns you to the previous menu level.
INFO	Displays context-sensitive information about the present menu level. Toggles information message on/off.

Voltage source

The built-in, bipolar, 1W voltage source can output up to ±1000V. With the instrument in the normal measurement mode, the programmed V-Source level is shown on the bottom line of the display.

Connections

WARNING ***To prevent electric shock that could cause injury or death, NEVER make or break connections to the instrument (or test circuit) while the V-Source is in operate (VOLTAGE SOURCE OPERATE indicator on). The OPER key toggles the V-Source between standby and operate.***

If used as an independent source, voltage is available at the V-SOURCE HI and LO terminals on the rear panel (see Figure 9). If used as an FVMI (force voltage measure current) source, V-Source LO can be internally connected to ammeter LO from the METER CONNECT option of the CONFIGURE V-SOURCE menu (see "Configuring V-Source"). Figure 10 shows the connections for this configuration.

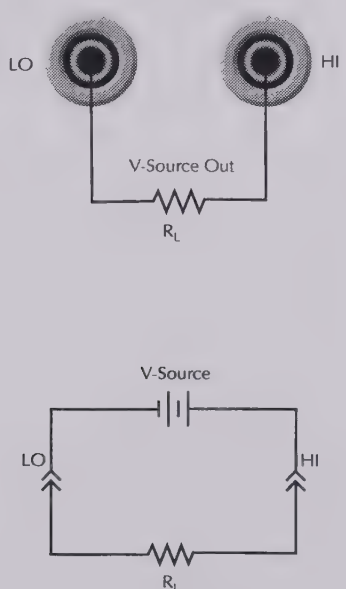
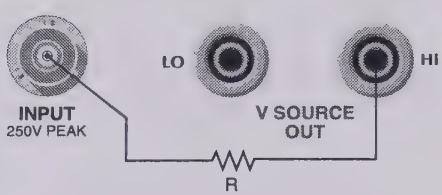
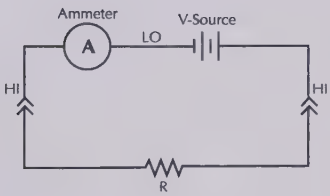


Figure 9
Independent V-Source connections

Figure 10
FVMI connections



Note: V-SOURCE LO connected to ammeter input LO via METER-CONNECT option of CONFIGURE V-SOURCE Menu.



Basic operation

Basic operation simply consists of setting the V-Source level, and placing the V-Source in operate to output the voltage. Other V-Source operations are performed from the CONFIGURE V-SOURCE menu. See "Configuring V-Source" to select range (100V or 1000V), set voltage limit, select resistance current limit and control the LO-to-LO connection between the V-Source and the ammeter.

Setting V-Source level — The V-Source level is set with the instrument in the normal measurement mode. The VOLTAGE SOURCE ▲ and ▼ keys, and the cursor keys (◄ and ►) are used to adjust the voltage level. Pressing any one of these four keys will enable the V-Source edit mode. The flashing digit on the V-Source display indicates the cursor position. Use the cursor keys to place the cursor on the desired digit, and use the VOLTAGE SOURCE ▲ and ▼ keys to adjust the level. Polarity can be changed by placing the cursor on the polarity sign, and pressing VOLTAGE SOURCE ▲ and ▼.

Sourcing voltage — The displayed voltage level is applied to the output terminals when the instrument is placed in operate by pressing the OPER key. In operate, the VOLTAGE SOURCE OPERATE indicator is on. Pressing OPER a second time places the V-Source in standby.

Configuring V-Source

Perform the following steps to configure the V-Source:

1. Press the CONFIG key and one of the VOLTAGE SOURCE keys (OPER, ▲ or ▼) to display the following configuration menu:

   RANGE: Select the 100V range or 1000V range.

   V-LIMIT: Control (on/off) and set a voltage limit (absolute value).

   RESISTIVE LIMIT: Control (on/off) the resistive (1MΩ) current limit.

   METER CONNECT: Control (on/off) the internal connection between V-Source LO and ammeter LO.

2. Use the menu items to configure the V-Source. A menu item is selected by placing the cursor (using the ◄ and ► keys) on it and pressing ENTER. Options for a menu item are selected in the same way. Parameter values are changed using the cursor keys and the RANGE keys, and then pressing ENTER. See "Menus" previously in this section if you need more information to navigate through the menu structure.
3. Use the EXIT key to back out of the menu structure.

Relative

Rel subtracts a reference value from actual readings. When rel is enabled, the instrument uses the present reading as a relative value. Subsequent readings will be the difference between the actual input value and the rel value.

Actual Input – Reference = Displayed Reading

The rel (relative) operation is enabled by pressing the REL key (REL annunciator turns on). Pressing REL a second time disables rel. You can also enter and enable a rel value from the CONFIG-REL display.

A rel value can be established for each measurement function. The state and value of rel for each measurement function are saved when changing functions. Once a rel value is established for a measurement function, the value is the same for all ranges.

Configuring Rel

To check or change a rel value for a measurement function, perform the following steps:

1. Select the desired measurement function.
2. Press the CONFIG key and then the REL key to display the present rel value.
3. Use the cursor keys (◀ and ▶) and the RANGE keys to change the rel value and press ENTER. The instrument will return to the normal display state with rel enabled.

Zero check

With zero check enabled ("ZeroCheck" displayed), the input signal is routed to low through a high impedance shunt. For volts, amps and ohms measurements, zero check should be enabled when connecting or disconnecting input signals. For charge measurements, zero check should be disabled. If left enabled, the charge will dissipate through the 10MΩ shunt.

The Z-CHK key is used to enable and disable zero check.

NOTE *To ensure proper operation, always enable zero check before changing functions (V, I, R or Q).*

Zero correct

The Z-CHK and REL keys work together to cancel (zero correct) any internal offsets that might upset accuracy for voltage and current measurements.

Perform the following steps to zero correct the volts or amps function:

1. Select the V or I function.
2. Enable Zero Check.
3. Select the range that will be used for the measurement, or select the lowest range.
4. Press REL to zero correct the instrument. The REL indicator turns on and the "ZCor" message is displayed.

NOTE *For the volts function, the "ZCor" message will not be displayed if guard was already enabled ("Grd" displayed).*

5. Press Z-CHK to disable zero check.
6. Readings can now be taken in the normal manner.

NOTES *The instrument will remain zeroed even if the instrument is upranged. If downranged, re-zero the instrument.*

To disable zero correct, first enable zero check and then press REL.

Triggering

The following overview is intended to acquaint you with triggering. For a complete explanation, see the Model 6517 User's Manual. Triggering is configured from the Trigger Configuration menu which is accessed by pressing CONFIG and then TRIG.

There are two trigger modes for the Model 6517; basic and advanced. These two trigger modes are summarized by the simplified trigger models shown in Figures 11 and 12. As shown in the drawings, the basic trigger model uses one layer of operation, while the advanced trigger model uses three layers to provide more trigger options.

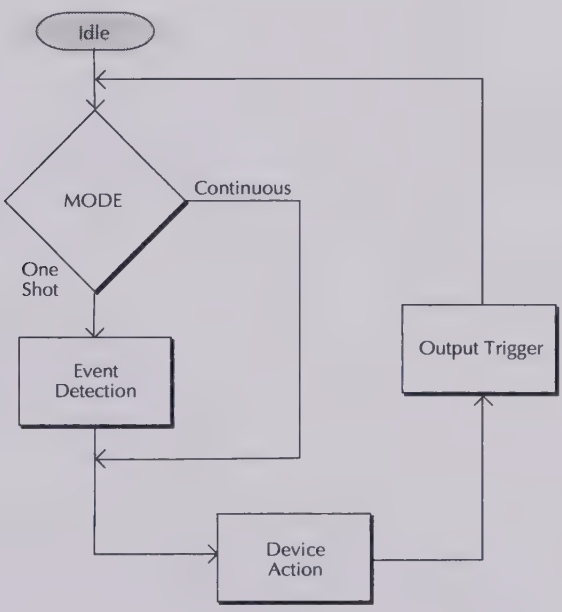


Figure 11
Basic trigger model (simplified)

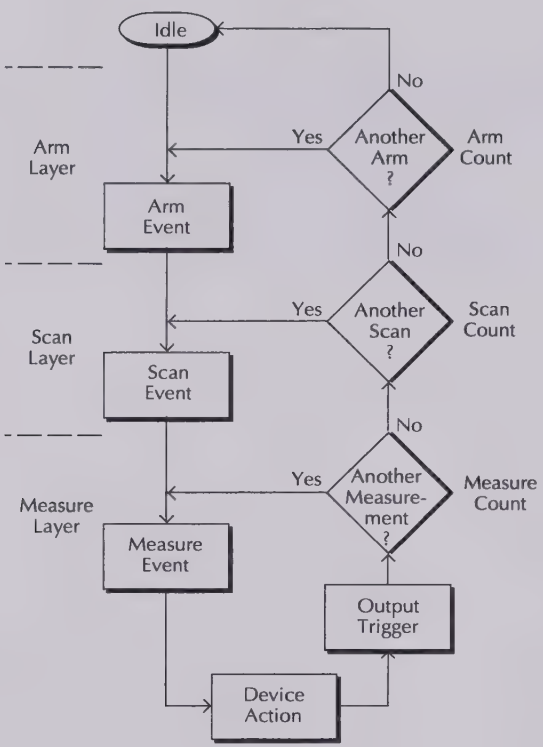


Figure 12
Advanced trigger model (simplified)

Idle

The instrument is in idle whenever it is not within one of the layers of the trigger model. When the Model 6517 is taken out of idle by pressing TRIG (or sending :INIT or :INIT:CONT ON over the bus), the ARM indicator turns on and operation proceeds in the trigger model.

Control sources

With advanced triggering and basic one-shot triggering, operation is controlled by control sources, which hold up operation until the programmed event occurs. Basic one-shot triggering uses one control source, while advanced triggering uses three control sources. The control sources are described as follows:

- Immediate – Event detection is immediately satisfied, allowing operation to continue.
- External – Event detection is satisfied when an input trigger via the EXT TRIG IN connector is received.
- Manual – Event detection is satisfied by pressing the TRIG key.

- GPIB – Event detection is satisfied when a bus trigger (GET or *TRG) is received.
- TrigLink – Event detection is satisfied when an input trigger via the TRIG LINK connector is received. Not available for basic triggering.
- TIMER – Event detection is immediately satisfied on the initial pass through the layer. Each subsequent detection is satisfied when the programmed timer interval elapses. Not available in the Arm Layer of the advanced trigger model.
- Hold – With this selection, event detection is not satisfied by any of the above control source events and operation is held up. Not available for basic triggering.

If continuous basic triggering is being used, then operation bypasses the control source as shown in Figure 11 and performs a device action.

Device action

The primary device action is a measurement. However, the device action could include a function change and a channel scan (if scanner is enabled). A channel is scanned (closed) before a measurement is made. When scanning internal channels, the previous channel opens and the next channel closes (break-before-make). Also included in the device action is the internal settling time delay for the relay.

Output trigger

After each measurement (device action), an output trigger pulse occurs and is available at the rear panel of the Model 6517. When used with an external scanner (such as a Model 7001 or 7002 Switch System), each output trigger would be used to select the next channel in a scan (see "External Scanning" later in this section).

Counters (Advanced triggering)

All three layers of the advanced trigger model use programmable counters that allow operation to return to or stay in the respective layer. For example, programming the Measure Layer counter to infinite keeps operation in the Measure Layer. After each device action, operation loops back to the Trigger Layer control source. A counter resets when operation loops back to a higher layer (or idle).

Bench default trigger model setup

The bench default setup selects advanced triggering and takes the Model 6517 out of idle, sets the control sources of all layers to Immediate, and sets the Measure Layer counter to infinite. With this trigger model setup, operation simply falls into the Measure Layer (and stays there) to make continuous measurements.

Speed

SPEED sets the integration time of the A/D converter, the period of time the input signal is measured. The SPEED can be set for each measurement function. The integration time is specified in parameters based on a number of power line cycles (NPLC), where one PLC for 60Hz is 16.67msec and one PLC for 50Hz and 400Hz is 20msec.

In general, the fastest integration time (0.01 PLC) results in increased reading noise and less usable resolution, while the slowest integration time (10 PLC) provides the best common-mode and normal-mode rejection. In-between settings are a compromise between speed and noise.

Configuring speed

Each measurement function, can have a unique integration time. Speed is set from the configure function menu structures. The procedure is summarized as follows:

1. Press the CONFIG key and then the desired function key (V, I, etc.).
2. Using the cursor keys (◄ and ►), select SPEED and press ENTER to display the following speed options:

   NORMAL: Sets the integration time to 1 PLC.

   FAST: Sets the integration time to 0.01 PLC.

   MEDIUM: Sets the integration time to 0.1 PLC.

   HIACCURACY: Sets the integration time to 10 PLC.

   SET-SPEED-EXACTLY: This options prompts you to enter a PLC value (0.01 to 10).

   SET-BY-RESOLUTION: Automatically optimizes the integration time for the present resolution setting (see the User's Manual).
3. Use the menu items to configure speed. A menu item is selected by placing the cursor (using ◄ and ► keys) on it and pressing ENTER. Parameter values are changed using the cursor keys and the RANGE keys, and then pressing ENTER. See MENUS if you need more information to navigate through the menu structure.

NOTE *For more information, see SPEED in Section 2 of the User's Manual.*

Resolution

All functions can operate from 3½ to 6½ digits of resolution. Each function can have a unique resolution setting.

Configure resolution

Perform the following steps to set resolution for a measurement function:

1. Press the CONFIG key and then the desired function key (V, I, etc.).
2. Using the cursor keys (◄ and ►), select RESOLUTION and press ENTER to display the following resolution options:

   3.5 to 6.5d: Select one of these options to set the display resolution.

   AUTO: This option automatically optimizes the resolution for the present integration time (speed) setting (see the User's Manual).
3. Set resolution by placing the cursor (using ◄ and ► keys) on the menu option pressing ENTER. See "Menus" if you need more information to navigate through the menu structure.

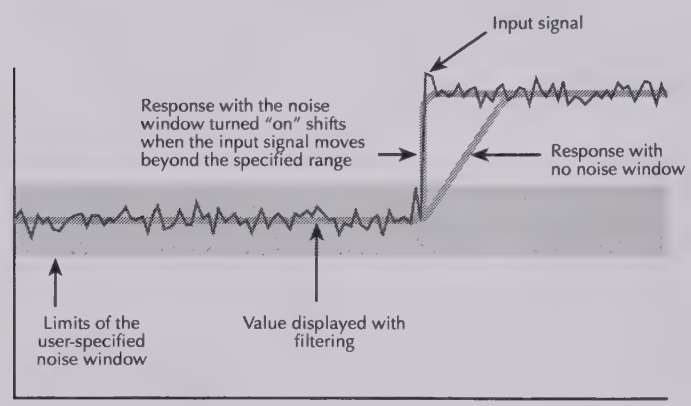
Filter

Filtering stabilizes noisy measurements. The Model 6517 uses a digital filter and a median filter. When a filter is enabled by pressing FILTER (FILT annunciator turns on), the selected filter for that measurement function is in effect. Pressing FILTER a second time disables the filter.

Filter types

The Model 6517 has two types of digital filters: averaging and advanced. Both types are a simple average of 1 to 100 reading conversions. The difference is a user-programmed noise "window" for the advanced filter. The noise window (expressed as a percentage of range) allows a faster response time to large signal step changes (see Figure 13). See the User's Manual for complete information on filter types.

Figure 13
Filter response/noise window


Input signal
Response with the noise window turned "on" shifts when the input signal moves beyond the specified range
Response with no noise window
Limits of the user-specified noise window
Value displayed with filtering

Filter modes

There are two filter modes: moving or repeating. The moving filter uses a first-in, first-out stack. When the stack becomes full, the measurement conversions are averaged, yielding a reading. For each subsequent conversion, the new conversion is placed into the stack, the oldest conversion is discarded, and a new reading is averaged.

For the repeating filter, the stack is filled and the conversions are averaged to yield a reading. The stack is then cleared and the process starts over. See the User's Manual for complete information on filter modes.

Median filter

Median filtering uses the "middle-most" reading from a group of sample readings arranged in ascending order. For example, assume the following readings:

20V, 1V, 3V

They are then arranged in ascending order as follows:

1V, 3V, 20V

The median ("middle-most") reading from the above sample group is 3V.

The number of sample readings is determined by the specified rank as follows:

Sample readings = $(2 \times R) + 1$

where: R is the selected rank (1 to 5)

For example, a rank of 4 will use the last nine readings to determine the median; $(2 \times 4) + 1 = 9$.

Each new reading replaces the oldest reading, and the median is then determined from the updated sample group of readings.

Configuring filters

Each measurement function has its own filter configuration. Perform the following steps to configure filter:

1. Select the measurement function.
2. Press CONFIG and then FILTER to display the following menu items:

   AVERAGING: This item is used to control and configure the digital filter.
   MEDIAN: This item is used to control and configure the median filter.
3. The menu structure for the two filters (Digital and median) is shown as follows:
   A. AVERAGING (Digital) filter options:

      TYPE — This item is used to select the digital filter type:
      NONE — Disables the digital filter.
      AVERAGING — Selects the averaging filter and prompts you to enter the number of readings to average ("stack" size).
      ADVANCED — Selects the advanced filter and prompts you to enter the number of readings to average ("stack" size). After entering the stack size, you are then prompted to enter the noise tolerance level (0 to 100%).

      AVERAGING-MODE — This menu item is used to select the filter mode; MOVING or REPEAT.
   B. MEDIAN filter options:

      DISABLE — Disables the median filter.

      ENABLE — Enables the median filter and prompts you to enter the range (1 to 5).
4. Use the menu items to configure a filter. A menu item is selected by placing the cursor (using ◀ and ▶ keys) on it and pressing ENTER. Parameter values are changed using the cursor keys and the RANGE keys, and then pressing ENTER. See "Menus" if you need more information to navigate through the menu structure.

NOTE *The filter configuration menus can also be accessed from the configure function menus.*

Buffer (Data Store)

The Model 6517 has a buffer that can store from one to over 15,000 readings. The actual number of readings that can be stored in the buffer depends on how many optional data elements are included for each reading (see Table 2-22 in the User's manual).

The basic data elements include the reading, units, reading # and status (overflow or underflow). In addition to these items, recalled data also includes statistical information, such as minimum, maximum, average and standard deviation, which are part of the NEXT displays (see "Multiple Displays" in Section 1).

Optional data elements include timestamp, humidity, external temperature, channel number (for scanning) and the V-Source level.

Storing readings

The following procedure to store readings uses a typical data store configuration: a user-defined number of readings will be stored in the buffer (fill-and-stop). All aspects of data store configuration and operation are detailed in Section 2 of the User's Manual.

1. Set up the instrument for the desired measurements (function, range, etc.).
2. Configure the data store as follows. A menu item is selected by placing the cursor (using ◄ and ► keys) on it and pressing ENTER. Parameters are changed using the RANGE keys and pressing ENTER. See MENUS if you need more information on navigating through the menu structure.
   - Press CONFIG
   - Press STORE
   - Select CONTROL
   - Select FILL-AND-STOP
   - Select ELEMENTS (y = enable, n = disable)
   - Select COUNT
   - Select ENTER-COUNT (enter buffer size)

   Note: If you enabled the TIMESTAMP data element, continue on to configure the timestamp. Otherwise, press EXIT to back out of the menu structure.

   - Select TIMESTAMP
   - Select TYPE
   - Select REAL-TIME
   - Select FORMAT
   - Select ABSOLUTE

   Use the EXIT key to back out of the menu structure.
3. Press STORE. The presently programmed buffer size (number of readings to store) is displayed. If desired, use the cursor keys and the RANGE keys to change the buffer size. (Incrementing the most significant digit sets the buffer size to maximum.)
4. Press ENTER to start storing readings. The asterisk (*) annunciator turns on to indicate a data storage operation.
5. To recall stored readings, press RECALL. Use the RANGE keys to scroll through the buffer.

Math

The MATH key lets you perform math operations on single readings and display the result. The six math calculations that are configured from the CONFIGURE MATH menu structure are:

Polynomial:

$$Y = (a2)X^2 + (a1)X + (a0)$$

where: X is the normal display reading
a2, a1, and a0 are user-entered constants
Y is the displayed result

Percent:

$$Percent = \frac{Input\ Reading}{Target\ Value} \times 100$$

where: Input Reading is the normal display reading
Target Value is the user-entered constant
Percent is the displayed result

Percent Deviation:

$$PD = \frac{(X - Y)}{Y} \times 100$$

where: X is the normal display reading
Y is the user-entered reference value
PD is the displayed result (percent deviation)

Deviation:

$$Deviation = \frac{(X - Y)}{Y}$$

where: X is the normal display reading
Y is the user-entered reference value
Deviation is the displayed result

Ratio:

$$Ratio = \frac{X}{Y}$$

where: X is the normal display reading
Y is the user-entered reference value
Ratio is the displayed result

Log10 (logarithmic):

$$log_{10}X = Y$$

where: X is the input reading
Y is the logarithmic result

Selecting and configuring math

The procedure to select and configure a math calculation is summarized as follows:

1. Press CONFIG and then MATH to display the following math filter menu options:
   NONE: Select no calculation when the MATH key is pressed.
   POLYNOMIAL: Select the polynomial calculation and enter the constants (a2, a1, and a0).
   PERCENT: Select the percent calculation and enter the target value (reference).
   % DEV: Select the percent deviation calculation.
   DEVIATION: Select the deviation calculation.
   RATIO: Select the ratio calculation.
   LOG10: Select the logarithmic calculation.
2. Use the menu items to select and configure math. A menu item is selected by placing the cursor (using ◄ and ► keys) on it and pressing ENTER. Parameter values are changed using the cursor keys and the RANGE keys, and then pressing ENTER. See "Menus" if you need more information to navigate through the menu structure.

Enabling math

The selected math calculation is enabled by simply pressing the MATH key. When enabled, the MATH annunciator turns on and the calculation type (NONE, POLY, %, or % DEV) is displayed. Also, one of the following messages is briefly displayed:

Math Enabled
Display = NONE (reading)

Math Enabled
Display = POLY (reading)

Math Enabled
Display = % (reading)

Math Enabled
Display = % DEV (reading)

Math Enabled
Display = DEV (reading)

Math Enabled
Display = RATIO (reading)

Math Enabled
Display = LOG10 (reading)

Math is disabled by pressing MATH a second time.

Additional math operations

In addition to the math performed on single readings described above, the Model 6517 has these math operations:

- Math performed on buffered readings (maximum and minimum values, average, and standard deviation).
- Math performed on single readings as part of a pass/fail limits test.

NOTE *Complete information on MATH is provided in Section 2 of the User's Manual.*

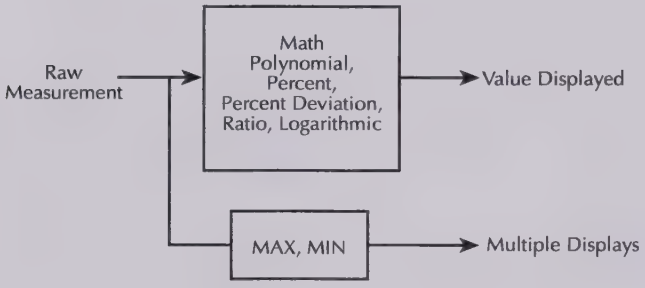


Figure 14
Combining math calculations

Test sequences

The following information summarizes the built-in test sequences of the Model 6517. Detailed information on test sequences can be found in the User's Manual.

Selecting and configuring a test sequence

A test sequence is selected and configured from the CONFIGURE SEQUENCE menu as follows:

1. Press CONFIG and then SEQ to display the sequence configuration menu.
2. Place the cursor (using ◄ and ► keys) on APPLICATIONS and press ENTER. Select and configure a test from the test sequence menu structure. To select a menu item, place the cursor (using ◄ and ► keys) on it and press ENTER. To change a parameter value, use the cursor and RANGE keys, and press ENTER.

   DEV-CHAR — Use to select a device characterization test:

   DIODE: Diode leakage current test — Specify start voltage, stop voltage, step voltage and delay.

   CAPACITOR: Capacitor leakage current test — Specify bias voltage, bias time, and discharge time.

   CABLE: Cable insulation resistance test — Specify bias voltage and bias time.

   RESISTOR: Resistor voltage coefficient test — Specify source 1 voltage, delay 1, source 2 voltage and delay 2.

   RESISTIVITY — Use to select a resistivity test:

   SURFACE: Surface resistivity test — Specify pre-discharge time, bias voltage, bias time, measure voltage, measure time and discharge time.

   VOLUME: Volume resistivity time — Specify pre-discharge time, bias voltage, bias time, measure voltage, measure time and discharge time.

   SIR — Surface insulation resistance test — Use to select the SIR test. Specify bias voltage, bias time, measure voltage and measure time.

   SWEEP — Use to select a sweep test:

   SQUARE-WAVE: Square wave sweep test — Specify high level voltage, time at high level, low level voltage, time at low level, and cycle count.

   STAIRCASE: Staircase sweep test — Specify start voltage, stop voltage, step voltage and step time.
3. Press EXIT to display the following menu:

   CONFIGURE SEQUENCE
   Applications Control

4. Place the cursor on CONTROL and press ENTER to display the control sources that can be used to start the test. Place the cursor on the desired control source and press ENTER.

   MANUAL — Pressing the TRIG key will start the test.

   IMMEDIATE — Test will start immediately after it is armed.

LID-CLOSURE — Test will start when lid of Model 8009 test fixture is closed.

GPIB — Test will start when a bus trigger (*TRG or GET) is received by the Model 6517.

EXTERNAL — Test will start when a trigger pulse (via EXT TRIG IN connector) is received by the Model 6517.

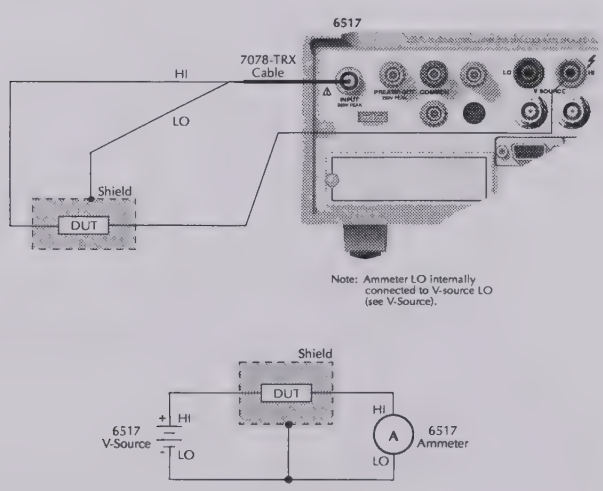
TRIGLINK — Test will start when a trigger pulse (via TRIG LINK connector) is received by the Model 6517. You will also be prompted to select the input line for the trigger.

Connections

WARNING ***Make sure the V-Source is in standby (VOLTAGE SOURCE OPERATE indicator off) before making or breaking connections to the Model 6517.***

Test sequences use the force voltage measure current (FVMI) technique as shown in Figure 15. This connection scheme assumes that V-Source LO is internally connected to ammeter LO. This connection is controlled from the METER CONNECT option of the CONFIGURE V-SOURCE menu (see V-Source). Note that Figure 15 does not meet the exact connection requirements for all the tests. It is only intended to show the general concept. More specific connection diagrams are provided in the User's Manual.

Figure 15
Typical FVMI connections



Running a test

After a test is selected, configured and connected, perform the following steps to run the test:

1. Press the SEQ key. The display message will indicate the selected test.
2. Press ENTER to arm the test. The blinking "SEQ" message will be displayed. The test will start when the selected control source event occurs. Note that if the Immediate control source is selected, the test will start as soon as it is armed.

NOTE *After the test is armed, the TRIG key can be used to start the test regardless of which control source is selected.*

3. When the test is finished, the "SEQ" display message is removed and the V-Source goes into standby.
4. Use the RECALL key to read the data from the buffer. Use the RANGE keys to scroll through the data points.

Internal scanning

The Model 6517 can be used with a scanner card (such as the Model 6521 or 6522) installed in the option slot of the instrument. This section provides basic information for scanning internal channels. If the scanner card is not already installed, refer to the scanner card instruction manual.

NOTES *For complete information on scanning (internal and external), refer to the scanner card instruction manuals.*

The scanner card has to be installed in the option slot in order to access the menus to configure and run an internal scan.

Configure internal scanner

Perform the following steps to configure an internal scan:

1. Press CONFIG and then CARD to display the scanning options (internal or external).
2. Place the cursor (using the ◄ and ► keys) on INTERNAL and press ENTER to display the menu items for the internal scanner.
3. Use the following menu structure to configure the internal scanner. To select a menu item, place the cursor (using the ◄ and ► keys) on it and press ENTER. Parameter values are changed using the cursor keys and the RANGE keys. If you need more information to navigate through the menu structure, see MENUS.

   CHANNELS — Selecting this menu item displays the status (on or off) for each channel. ON indicates that the channel will be included in the scan, while OFF indicates that the channel will not be included in the scan. To change the status of a channel(s), place the cursor on that channel and press a RANGE key. When finished, press ENTER.

   SCAN-MODE — Use this menu item to set the scan mode. The VOLTAGE scan mode is faster and can be used when break-before-make switching is not required.

   VSRC-LIMIT — Use this menu item to enable (YES) or disable (NO) the 200V V-Source limit. The ±200V limit is used to protect the scanner card. Note that a V-Source limit (0 to ±1000V) may also be set from the Configure V-Source menu (see V-SOURCE).

   SETTLING-TIME — Use this menu item to set a settling time (0 to 999.999 seconds) for each channel. Be sure to press ENTER after changing the time period.
4. Use the EXIT key to back out of the menu structure.

Perform the scan

Perform the following steps to scan internal channels. Note that menu items are selected by placing the cursor (using ◄ and ► keys) on it and pressing ENTER. Parameter values are changed using the cursor and RANGE keys and pressing ENTER. If you need more information on navigating the menu structure, see "Menus".

1. Set up the Model 6517 for the desired measurement (i.e., function, range, filter, etc.).
2. Press CARD to display the internal scanner options (close channel or perform scan).
3. Select PERFORM-SCAN to display the scan types (internal or external).
4. Select INTERNAL to display the scan count. The scan count indicates the number of items the scan will be repeated.
5. If desired, change the scan count and press ENTER.
6. You will then be asked if you wish to use the scan timer to provide a time interval between scans:
   A. Yes — To use the timer, select YES. The present interval (in seconds) will be displayed. If desired, change the interval. Press ENTER to continue.
   B. No — If you do not wish to use the timer, select NO.
7. You will then be asked if you wish to store the readings in the buffer:
   A. Yes — To use the buffer, select YES. A message indicating the number of readings that will be stored in the buffer will be displayed. Press ENTER to continue.
   B. No — If you do not wish to use the buffer, select NO.
8. With the message "Press ENTER to begin" displayed, press ENTER to start the scan.
9. After the scan is finished, the following options are available:
   A. Recall data — If readings were stored in the buffer, select RECALL-DATA to display the stored readings. Use the RANGE keys to scroll through the data points.
   B. Scan again — If you wish to repeat the scan(s), select SCAN-AGAIN. Press ENTER to start the scan.
   C. Exit — To return to the normal measurement mode, select EXIT. Note that stored readings can still be displayed by pressing the RECALL key.

Close/Open channels

Perform the following steps to open or close a channel on an internal scanner card:

1. Press the CARD key to display the internal scanner options (close channel or perform scan).
2. Place the cursor (using ◄ and ►) on CHANNEL-CLOSURES and press ENTER.
3. The following channel closure options are available:
   A. Close channel — To close a channel, place the cursor on CLOSE-CHANNEL and press ENTER. Use the RANGE keys to display the channel that you wish to close and press ENTER. The number of the closed channel will be displayed along with the reading.
   B. Open channels — To open all channels on the scanner card, place the cursor on OPEN-ALL-CHANNELS and press ENTER.

External scanning

The Model 6517 can be used with a scanner card (such as the Model 7158 Low Current Multiplexer Card) installed in an external scanning mainframe (Model 7001 or 7002 Switch System). With the use of external triggering, the Model 6517 can measure and store each scanned channel.

NOTE *For complete information on scanning (external and internal), refer to Section 2 in the User's Manual, and the switch system and scanner card instruction manual.*

NOTE *The following steps assume that the Model 6517 is set to the BENCH reset default conditions (see "Bench Default" in Section 2) and the Model 7001/7002 is set to the RESET default conditions.*

Trigger connections

If using Trigger Link, connect the Model 6517 to the switch system as shown in Figure 16. If using conventional external triggering, connect the instruments as shown in Figure 17. Detailed information on triggers is provided in Section 2 of the User's Manual.

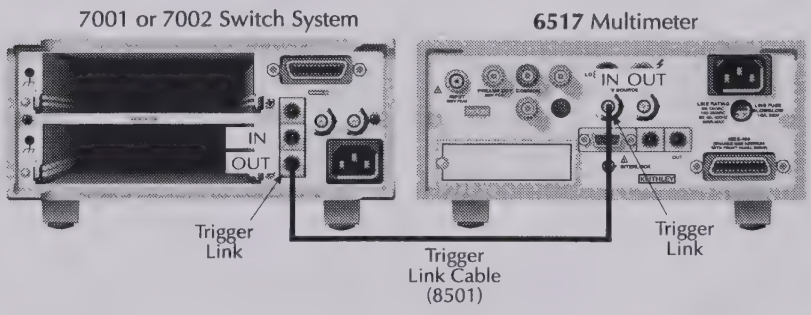


Figure 16
Trigger connections using trigger link

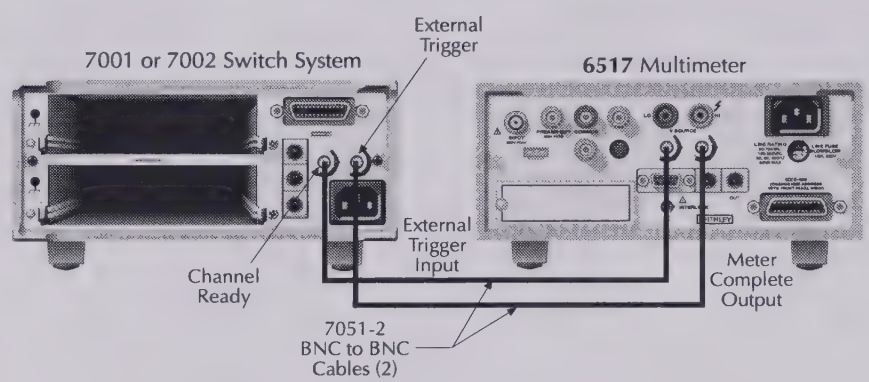


Figure 17
Trigger connections using conventional external triggering

Configure external channels

The scanner configuration menu is used to specify the number of channels (external inputs) for the scan. If a scanner card is installed in the option slot of the Model 6517, use procedure A. If the option slot is empty, use procedure B.

Procedure A — Scanner installed in option slot of Model 6517.

1. Press CONFIG and then CARD to display the scanner configuration menu.
2. Place the cursor (using ◄ and ► keys) on EXTERNAL and press ENTER.
3. You will then be prompted to enter the number of external inputs (channels) for the scan. Use the cursor keys and RANGE keys to change the number (1 to 400). Press ENTER to continue.
4. Press EXIT to return to the normal measurement display.

Procedure B — Option slot of Model 6517 empty.

1. Press CONFIG and then CARD to display the scanner configuration menu.
2. You will then be prompted to enter the number of external inputs (channels) for the scan. Use the cursor keys (◄ and ►) and RANGE keys to change the number (1 to 400).
3. Press ENTER to return to the normal measurement display.

Perform the scan

Perform the following steps to scan external channels. Note that menu items are selected by placing the cursor (using ◄ and ► keys) on it and pressing ENTER. A parameter value is changed by using the RANGE keys and pressing ENTER.

1. Model 6517 — Press the CARD key. If a scanner card is installed in the option slot of the Model 6517, perform steps A and B. If the option slot is empty, proceed to step 2.
   A. Place the cursor on PERFORM-SCAN and press ENTER to display the scan types (external or internal).
   B. Place the cursor on EXTERNAL and press ENTER.
2. Switch System — If not already done, reset the Model 7001/2 as follows:
   - Press MENU
   - Select SAVESETUP
   - Select RESET
   - Select ENTER
   - Select ENTER

   Use the EXIT key to back out of the menu structure.
3. Model 6517 – Press ENTER to display the next message; "CONFIG EXT SCANNER; Set CHAN COUNT to infinite".
4. Switch System – Set the channel count to infinite as follows:
   - Press SCAN
   - Select SELECT-CONTROL
   - Select NUMBER-OF-CHANS
   - Select CHAN-COUNT
   - Select INFINITE

   Note: Do not exit from the menu structure after selecting an infinite channel count.
5. Model 6517 – Press ENTER to display the next message ("SELECT TRIG SOURCE"), and select the appropriate trigger source. If using the Trigger Link, select TRIGLINK. If you are instead using conventional external triggering, select EXTERNAL. The "CONFIG EXT SCANNER" message to set channel spacing for the Switch System will then be displayed.
6. Switch System – Set channel spacing as follows. Note that the message on the Model 6517 tells you which channel spacing option to select.
   - Select CHANNEL-SPACING
   - Select TRIGLINK or EXTERNAL

   Use the EXIT key to back out of the menu structure.
7. Model 6517 – Press ENTER. The display will prompt you to define the scan list for the Switch System.
8. Switch System – Define the scan list.
9. Model 6517 – Press ENTER to display "CONFIG EXT SCANNER; STEP scanner to first channel".
10. Switch System – Press STEP to close the first channel in the scan.

11. Model 6517 – Press ENTER to display the currently programmed scan count. The scan count specifies the number of scans to be performed. To change the scan count, use the cursor keys (◄ and ►) and RANGE keys (▲ and ▼). Press ENTER to continue.
12. Model 6517 – You will then be asked if you wish to use the scan timer. The timer is used to provide a time interval between each scan. If you select YES, enter the interval (in seconds).
13. Model 6517 – You will then be asked if you wish to store the readings in the buffer. If you select YES, a message indicating the total number of readings to be stored in the buffer will be displayed. Press ENTER to continue.
14. Model 6517 – With the message "Press ENTER to begin" displayed, press ENTER to start the scan process.
15. After the scan is completed, options to recall readings or repeat the scan will be displayed:
    - RECALL-DATA – Select this option to recall readings. Use the cursor keys and the range keys to scroll through the buffer. When finished, press EXIT to return to the post-scan options.
    - SCAN-AGAIN – Use this option to repeat the scan.
    - EXIT – Use this option to disable the scan.

3
Remote Operation

Overview

For remote operation, the Model 6517 can use the IEEE-488 interface or the RS-232 interface. Common commands and SCPI commands can be used with either interface.

For IEEE-488 operation, you can select the DDC language mode. In this mode, you use device-dependent commands (DDCs) instead of command commands and SCPI commands. This mode allows you to use the Model 6517 as a "drop-in" replacement for the Model 617 Electrometer. Existing programs written for the Model 617 can be used by the Model 6517 without having to make any code modifications. Appendix G of the User's Manual lists the DDCs for the Model 6517.

Software support

The following software tools are included with the Model 6517:

TestPoint Application Software

There are two run-time TestPoint applications on the supplied disk. One of the applications utilizes an optional scanner card and the other is a complex interactive application. Among the many operations, the interactive application allows you to select function and range, make measurements, store readings in the buffer, graph the results and/or export the data to a Microsoft Windows Excel file. These run-time applications are compatible with any PC using Windows 3.0 or higher, and require the use of a Keithley KPC-488 series interface card. A TestPoint library for the Model 6517 is included, so that these applications can be readily customized using TestPoint.

Demonstration/Startup Programs

Five QuickBASIC example programs are included on the TestPoint disk to familiarize you with the use of SCPI commands.

LabView Driver

This driver allows you to use the Model 6517 with the National Instruments LabView package and is free upon request. Contact the Keithley Applications group for details (1-800-348-3735).

IEEE-488 bus standards

For remote operation, the Model 6517 can use the IEEE-488 bus for communication between instrumentation and the controller (computer). The IEEE-488 bus is also known as the GPIB (General Purpose Interface Bus).

In addition to conforming to the IEEE-488-1978 and IEEE-488.1-1987 standards, the Model 6517 also conforms to the IEEE-488.2-1987 standard and the SCPI 1994 (Standard Commands for Programmable Instruments) standard. These two standards allow most instrument operations to be performed with the use of command commands and SCPI commands.

RS-232 standard

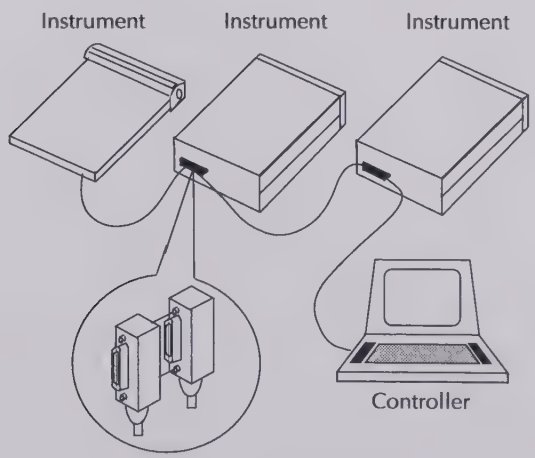
For remote operation, the Model 6517 can use the RS-232 serial port for communication between instrumentation and the controller (computer). All commands, except DDCs, can be used over this serial port. The serial port is based on the electrical and mechanical characteristics of the RS-232-C standard.

IEEE-488 bus connections

The Model 6517 is connected to the IEEE-488 bus using a cable terminated with standard IEEE-488 connectors. Figure 18 shows a typical connection scheme for a multi-unit test system. Note that connectors can be stacked to accommodate the parallel connection scheme.

To minimize interference caused by electromagnetic radiation, only use shielded IEEE-488 cables, such as the Keithley Models 7007-1 and 7007-2.

Figure 18
IEEE-488 connections



RS-232 connections

The RS-232 serial port of the Model 6517 can be connected to the serial port of a computer using a standard, straight-through (not null modem) RS-232 cable terminated with DB-9 connectors. The serial port is located on the rear panel of the Model 6517 and is labeled "RS232".

If your computer uses a DB-25 connector for the RS-232 interface, you will need a cable or an adapter with a DB-25 connector on one end and a DB-9 connector on the other end. Again, make sure it is wired straight-through (not null modem).

IEEE-488 interface, address and language selection

The Model 6517 is shipped from the factory with the IEEE-488 bus selected, the primary address set to 27 and the SCPI language mode selected. The primary address is displayed on power-up if the IEEE-488 bus is the selected interface. Note that the IEEE-488 bus is also known as the GPIB (General Purpose Interface Bus).

Perform the following steps to select the IEEE-488 bus interface, check and/or change the primary address, and check and/or change the language mode:

1. Press MENU to display the MAIN MENU.
2. Place the cursor (using ◄ and ► keys) on COMMUNICATION and press ENTER. The interface options (GPIB and RS-232) will then be displayed.
3. Place the cursor on GPIB and press ENTER to select the IEEE-488 bus interface.

NOTE *If the RS-232 interface was previously selected, the unit will exit from the MAIN MENU when you select GPIB. In that event, to repeat steps 1, 2 and 3 to continue in the menu structure.*

4. Perform the following steps if you wish to check and/or change the primary address:
   A. Place the cursor on ADDRESSABLE and press ENTER to display the addressable menu items (ADDRESS and LANGUAGE).
   B. Place the cursor on ADDRESS and press ENTER to display the primary address.
   C. To change the address, use the cursor keys and the RANGE keys to display the desired address, and press ENTER.

NOTE *Each device on the bus must have a unique address. Typically, the computer uses address 0 or 21.*

5. Perform the following steps if you wish to check and/or change the language mode:
   A. Place the cursor on LANGUAGE and press ENTER to display the language options (SCPI or DDC). Cursor position indicates the present language mode.
   B. Place the cursor on the desired language and press ENTER.

NOTE *Changing the language mode, causes the unit to exit from the MAIN MENU. If you did not change the language, then use the EXIT key to back out of the menu structure.*

RS-232 interface selection and configuration

Perform the following steps to select, check and/or change the RS-232 interface settings for the Model 6517:

NOTE *The RS-232 settings (baud rate, data bits, parity and stop bits) of the Model 6517 must match the RS-232 settings of the communications package for your computer.*

1. Press MENU to display the MAIN MENU.
2. Place the cursor (using ◄ and ► keys) on COMMUNICATION and press ENTER. The interface options (GPIB and RS-232) will then be displayed.
3. Place the cursor on RS-232 and press ENTER to select the RS-232 interface.

NOTE ***If the GPIB interface was previously selected, the unit will exit from the MAIN MENU when you select RS-232. In that event, repeat steps 1, 2 and 3 to continue in the menu structure.***

4. Perform the following steps if you wish to check and/or change the baud rate:
   A. Place the cursor on BAUD and press ENTER to display the available baud rates. Cursor position indicates the present baud rate setting. To retain the present baud rate setting, press ENTER or EXIT.
   B. To change the baud rate, place the cursor on the desired setting and press ENTER.
5. Perform the following steps if you wish to check and/or change the number of data bits:
   A. Place the cursor on BITS and press ENTER to display the available number of data bits (7 or 8). Cursor position indicates the present setting. To retain the present setting, press ENTER or EXIT.
   B. To change the number of data bits, place the cursor on the alternate selection and press ENTER.
6. Perform the following steps if you wish to check and/or change parity:
   A. Place the cursor on PARITY and press ENTER to display the parity options (NONE, ODD or EVEN). Cursor position indicates the present setting. To retain the present setting, press ENTER or EXIT.
   B. To change parity, place the cursor on the desired selection and press ENTER.
7. Perform the following steps if you wish to check and/or change the number of stop bits:
   A. Place the cursor on STOP and press ENTER to display the available number of stop bits (1 or 2). Cursor position indicates the present setting. To retain the present setting, press ENTER or EXIT.
   B. To change the number of stop bits, place the cursor on the alternate selection and press ENTER.
8. Use the EXIT key to back out of the menu structure.

Common commands

Common commands are common to all IEEE-488 devices on the bus. The following information summarizes the common commands that are used most often. For complete details, refer to Section 3 in the User's Manual.

*CLS
(clear status)

Clears all event registers and Error Queue. After clearing an event register, you can monitor the register for a bit to set, indicating that an event (such as the buffer becoming full) has occurred.

*RCL <NRf>
(recall)

Returns the instrument to the instrument setup saved at the specified memory location. Example: To recall the setup saved at memory location 0, send `*RCL 0`.

*RST
(reset)

Returns the instrument to the *RST defaults and places the instrument in the idle state (ARM indicator off).

*SAV <NRf>
(save)

Saves the instrument setup to the specified memory location (0 to 9). Example: To save the setup to memory location 0, send `*SAV 0`.

*TRG
(trigger)

When a trigger model control source is set for BUS, event detection is satisfied by sending this bus trigger. For example, if instrument operation is waiting at the measure (trigger) layer control source and it is programmed for BUS events, `*TRG` will provide the required event resulting in a device action (measurement).

*WAI
(wait to continue)

This delay is used to allow the `*TRG` or an initiate command (`:INIT` or `:INIT:CONT ON`) to finish before processing any further commands. An `INITiate` command is not considered finished until instrument operation returns to the idle state.

SCPI commands

In the Model 6517, you are given access to control settings that are hidden on other instruments. Because the instrument has more control points available, it requires more commands than its counterparts to perform comparable tasks. To accommodate this, the instrument incorporates the Standard Commands for Programmable Instruments (SCPI) command set.

This introduction to the SCPI command set has three goals:

- Describe the syntax of SCPI commands. Included are descriptions of short forms and default nodes, which help reduce the amount of data sent to the instrument.
- Provide some simple programs to perform commonly used tasks.
- Describe the SCPI commands used in the example programs so you can modify the programs to suit your needs.

SCPI command syntax

Tree structure

SCPI commands are organized in a tree structure, similar to disk directories in computer operating systems. Each subdirectory is called a subsystem. For example, part of the SENSe1 subsystem is listed below and shown in Figure 19.

```
[SENSe[1]]
  :DATA?
  :FUNCtion <name>
  :VOLTage
    [:DC]
      :RANGE
        [:UPPer] <n>
        :AUTO <Boolean> | ONCE
      :REFerence <n>
        :STATe <Boolean>
        :ACQuire
```

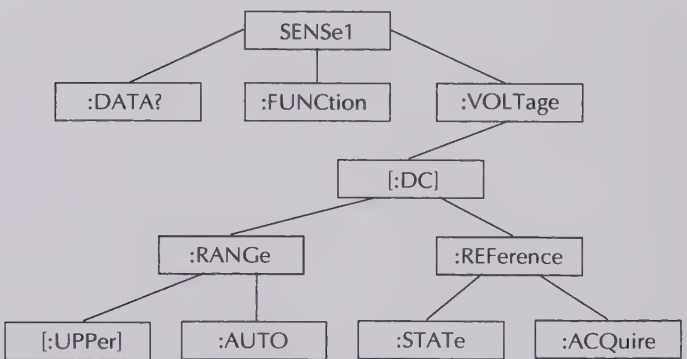


Figure 19
Hierarchy of the example SENSe1 commands

A command summary table is a way of documenting SCPI commands, but it does not show complete command names. A complete command is formed by joining the components. For example, the complete :STATe command in the example is:

```
SENSe1:VOLTage[:DC]:REFerence:STATe
```

Note that square brackets are not part of the command; they indicate optional parts of the command.

This hierarchical approach permits the same command to be used many times. For example, many subsystems contain a `:STATe` command, but each one is unique because the complete command is unique. This is analogous to having a file named INDEX.TXT, for example, in each directory of your computer's hard disk. Although the files have the same name, they are unique because they are each in a different directory.

Long and short form commands

Every SCPI command has a short form, and most also have a long form. The notation used in documentation shows the short form in upper case, with the remainder of the name, which creates the long form, shown in lower case. There are no intermediate forms of the command name. You must send the exact short or long form. However, you do not have to use the mixed capitalization. The Model 6517 accepts commands in any combination of upper and lower case. For example, all of the following are valid forms of the `SENSe1:VOLTage[:DC]:REFerence` command:

```
sense1:voltage[:dc]:reference:state
sens1:volt[:dc]:ref:stat
SENS1:volt[:DC]:rEFErENCe:STat
```

Query commands

With few exceptions, every SCPI command has a corresponding query. A command sets a control point in the instrument; a query determines the present setting of the control point. The query is simply the command name with a "?" attached.

Some commands are actions rather than control point settings. These commands have no query form. For example,

```
SENSe1:VOLTage[:DC]:REFerence:ACQuire
```

is an action command, not a setting, and so has no query form.

There are some queries that have no corresponding command. For example, `SENSe1:DATA?` causes the instrument to return the latest reading. Of course, there is no corresponding command to send a reading value to the instrument.

Default nodes

SCPI uses the concept of default nodes. Consider the example command tree shown previously in Figure 19. What is within square brackets is not necessary to send to the instrument, but the instrument will accept it if you send it. Consider the `:UPPer` command, which sets the measurement range. To set the Model 6517 to measure 15VDC, any of the following commands works:

```
SENSe1:VOLTage[:DC]:RANGe:UPPer 15
SENSe:VOLTage[:DC]:RANGe:UPPer 15
SENSe1:VOLTage[:DC]:RANGe 15
VOLTage[:DC]:RANGe:UPPer 15
VOLTage[:DC]:RANGe 15
```

These are shown in long form, but short forms could also be used.

Command syntax

Notice in the preceding examples that there is no colon character at the beginning of the commands. A leading colon instructs the Model 6517 to interpret the command starting at the root (highest level) of the command tree. Since the Model 6517 also starts at the root each time you send it a new command, the leading colon is not needed (although the instrument will accept it if you send it).

You can send multiple commands in a single message. You separate the commands with a semicolon character. When the Model 6517 encounters a command following a semicolon, it attempts to interpret the command starting at the level of the previous command, unless you precede the second command with a colon. For example, either of the following command strings programs the Model 6517 to the 20V range and uses 5V as a relative value (with the REFerence commands):

```
volt[:dc]:rang 20;ref 5;ref:stat on
volt]:dc]:rang 20;:volt[:dc]:ref 5;:volt[:dc]:ref:stat on
```

The two command strings are treated identically by the Model 6517. In the first string when the instrument encounters `";ref 5"`, it notices the following:

- It is not the first command in the string.
- There is no leading colon on the command.
- The previous command was at the `VOLTage[:DC]` level.

Therefore, it interprets the command as if it were at the `VOLTage[:DC]` level.

SCPI signal oriented commands

Signal oriented commands are used to acquire readings using a set of high-level instructions to control the measurement process. The two most commonly used commands are `:FETCh?` and `:MEASure?`.

Details on all signal oriented commands are covered in Section 3 in the User's Manual.

:FETCh?

This query command is used to request the latest post-processed reading. After sending this command and addressing the Model 6517 to talk, the reading will be sent to the computer. This command does not trigger a measurement, it simply requests the last available reading.

:MEASure[:<function>]?

In general, this command places the instrument in the "one-shot" measurement mode (ARM indicator off), triggers a single measurement, and then performs a `:FETCh?`.

If you include the measurement function with this command, the instrument will first go to the specified function and then perform the one-shot measurement and query, as follows:

`:MEASure?`	Currently selected function
`:MEASure:VOLTage[:DC]?`	Volts function
`:MEASure:CURRent[:DC]?`	Amps function
`:MEASure:RESistance?`	Ohms function
`:MEASure:CHARge?`	Coulombs function

SCPI subsystem commands

Detailed information an all SCPI commands is covered in the User's Manual. In this section, only the commands used for basic operation are summarized.

Defaults

`:SYSTem`
SYSTem Subsystem

`:PREset`
Set the 6517 to the system present defaults. Some of the selected defaults include: volts, continuous triggers, normal speed (1.0 PLC) and auto range.

`:POSetup <name>`
Select power-on setups: `RST`, `PRESet` or `SAV0` through `SAV9`. Instrument will power up to the `*RST` or system present defaults, or one of the `*SAV0` – `*SAV9` setups.

Fresh readings

`[:SENSe[1]]`
SENSe Subsystem

`:DATA:FRESh?`
Requests a "fresh" reading. This command will not request the same reading twice. If a new reading has already been triggered, this command will wait until the new reading is available.

`:CALCulate[1]`
CALCulate Subsystem

`:DATA:FRESh?`
Requests a "fresh" calculated reading. When CALC1 is enabled, `sens:data:fres?` is the reading before calculation and `calc:data:fres?` is the reading after calculation. When CALC1 is disabled, the readings are the same.

Function configuration

`[:SENSe[1]]`
SENSe Subsystem

`:FUNCtion <name>`
Select measurement function:

`<name> = 'VOLTage[:DC]'`	Volts function
`'CURRent[:DC]'`	Amps function
`'RESistance'`	Ohms function
`'CHARge'`	Coulombs function

```
:VOLTage[:DC]                    Path to configure volts:
  :NPLC <n>                        Set speed: 0.01 to 10 PLC.
    :AUTO <b>                        Enable or disable auto NPLC.
  :RANGe                           Path to configure measurement range:
    [:UPPer] <n>                     Specify expected reading to select range.
    :AUTO <n>                        Enable or disable auto range.
  :REFerence <n>                   Specify reference (rel): -210 to +210.
    :STATe <b>                       Enable or disable reference (rel).
    :ACQuire                         Use input signal as reference (rel).
  :DIGits <n>                      Specify measurement resolution.
    :AUTO <b>                        Enable or disable auto resolution.
  AVERage                          Path to control digital filter:
    :TYPE <name>                     Select filter (NONE, SCALar or ADVanced).
    :TCONtrol <name>                 Select averaging method (REPeat, or MOVing).
    :COUNt <n>                       Specify filter count (1 to 100).
    :ADVanced                        Path to configure advanced filter:
      :NTOLerance <n>                  Specify noise tolerance (1 to 100%).
    [:STATe] <b>                     Enable or disable digital filter.
  :MEDian                          Path to control median filter:
    :RANK < n>                       Specify rank for filter (1 to 5).
    [:STATe] <b>                     Enable or disable median filter.
  :GUARd <b>                       Enable or disable guard.

:CURRent:DC                      Path to configure Amps:
  (Volts commands)                 The commands for Volts (except :GUARd) apply.
  :DAMPing <b>                     Enable or disable damping.

:RESistance                      Path to configure Ohms:
  (Volts commands)                 The commands for Volts (except :GUARd) apply.
  [:AUTO]                          Path to configure Auto V-Source Ohms:
    :RANGe                           Path to set measurement range:
      [:UPPer] <n>                     Select range (0 to 100e18).
      :AUTO <b>                        Enable or disable auto range.
  :MANual                          Path to configure Manual V-Source Ohms:
    :CRANge                          Path to set measurement range:
      [:UPPer] <n>                     Select range (0 to 100e18).
      :AUTO <b>                        Enable or disable auto range.
    :VSOurce                         Path to control the V-Source.
      [:AMPLitude] <n>                 Specify V-Source level (0 to 1000).
      :RANGe <n>                       Set range; ≤100 = 100V range, >100 = 1000V
                                         range.
      :OPERate <b>                     Enable or disable V-Source output.
  :IREFerence <b>                  Enable or disable amps reference.
  :DAMPing <b>                     Enable or disable damping.
  :VSControl <name>                Select ohms V-Source mode (MANual or AUTO).
  :MSELect <name>                  Select ohms type (NORMal or RESistivity).
  :RESistivity                     Path to configure resistivity:
```

```
    :STHickness <NRf>          Volume — Specify sample thickness; 0.0001 to
                                 99.9999 (mm).
    :FSELect <name>            Select test fixture (M8009 or USER).
    :M8009                     Path to query Model 8009 test fixture:
      :RSWitch?                  Query switch setting (SURFace or VOLume).
    :USER                      Path to configure user test fixture.
      :RSELect <name>            Select test type (SURFace or VOLume).
      :KSURface <NRf>            Surface — Specify Ks; 0.001 to 999.999.
      :KVOLume <NRf>             Volume — Specify Kv; 0.001 to 999.999.

  :CHARge                    Path to configure Coulombs:
    (Volts commands)           The commands for Volts (except :GUARd) apply.
    :ADIScharge                Path to control auto discharge.
      :LEVel <NRf>               Set level (-2.2e6 to 2.2e6).
      [:STATe] <b>               Enable or disable auto discharge.
```

V-Source

```
:SOURce                        SOURce Subsystem
  :VOLTage <n>                 Specify V-Source level (0 to ±1000V).
    :RANGe <n>                   Select range; ≤100 = 100V range, >100 = 1000V
                                   range.
    :LIMit                       Path for voltage limit:
      [:AMPLitude] <n>             Specify voltage limit; 0 to 1000 (V).
      :STATe <b>                   Enable or disable limit.
    :MCONnect <b>                Enable or disable V-Source LO to ammeter LO con-
                                   nection.
  :CURRent                     Path for current limit:
    :RLIMit                      Path to control resistive current limit:
      :STATe <b>                   Enable or disable resistive I-limit.
    :LIMit <b>                   Path to check current compliance:
      [STATe]? <b>                 Query state of current compliance.
```

Data store (Buffer)

:TRACe	TRACe Subsystem
:ELEMents <name>	Select reading elements :TSTamp, HUMidity, CHANnel, ETEMperature, VSOurce, NONE.
:POINts <n>	Specify buffer size.
:FEED	Path to control buffer:
:CONTrol <name>	Select control mode and enable buf fer: NEVer, NEXT, ALWays or PRETrigger.
:DATA?	Read all readings in buffer..

Note: See User's Manual to use :PRETrigger.

Open/close channels and scan

:ROUTe	ROUTe Subsystem
:CLOSe <list>	Close specified channel.
:STATe?	Query the closed channel.
:OPEN <list>	Open specified channel.
:OPEN:ALL	Open all channels.
:SCAN	Path to control scanning:
[:INTernal] <list>	Specify internal scan list: 2 to 10 chans.
:EXTernal <list>	Specify external scan list: 2 to 400 chans.
:SMEThod<name>	Specify settling time for internal card; 0 to 99999.9999 (sec.).
:LSELect <name>	Enable the specified scan: INTernal, EXTernal or NONE.

Trigger model

Performing a system preset (:SYSTem:PRESet) configures the advanced trigger model for typical instrument operation. After a system preset, many advanced operations can be accomplished using the initiate commands, :ABORt, and the trigger (measure) layer commands.

```
:INITiate
  [:IMMediate]                Take the instrument out of idle (ARM indicator on).
  :CONTinuous <b>             Enable or disable continuous initiation.

:ABORt                        Reset trigger system. Instrument stays in idle if continu-
                              ous initiation is disabled (off).

:TRIGger                      Path to configure the advanced trigger layer:
  :SOURce <name>                Select control source: IMMediate, TIMer, MANual,
                                  BUS, TLINk, EXTernal or HOLD.
  :TIMer <n>                    Set timer interval (sec): 0 to 9999999.999.
  :DELay <n>                    Set delay between measurements (sec) 0 to
                                  999999.999.

:SYSTem
  :MACRo
    :TRIGger                  Path to configure basic triggering.
      [:EXECute]                Select basic triggering.
      :MODE <name>              Specify trigger mode (CONTinuous or ONE-
                                  Shot).
      :SOURce <name>            Specify source (IMMediate, MANual, BUS,
                                  EXTernal or TIMer).
      :TIMer <n>                Specify timer interval; 0.001 to 99999.999 (sec.).
```

Test sequences

:TSEQuence	TSEQuence subsystem.
:ARM	Arms selected test sequence.
:ABORt	Stops a test sequence in process.
:TYPE <name>	Specify test; DLEakage, CLEakage, CIResistance, RVCoefficient, SRESistivity, VRESistivity, SIResistivity, SQSWeep, STSWeep.
:TSOurce<name>	Specify trigger source; MANual, IMMediate, BUS, TLINk, EXTernal, LCLosure.
:TLINe <NRf>	Specify TLINK line; 1 to 6.
DLEakage	Diode leakage test path:
:STARt <NRf>	Specify start voltage; -1000 to 1000.
:STOP <NRf>	Specify stop voltage; -1000 to 1000.
:STEP <NRf>	Specify step voltage; -1000 to 1000.
:MDELay <NRf>	Specify measure delay; 0 to 99999.9 (sec.).
:CLEakage	Capacitor leakage test path:
:SVOLtage<NRf>	Specify bias voltage (-1000 to 1000).
:STIME <NRf>	Specify bias time; 0 to 99999.9 (sec.).
:DTIMe <NRf>	Specify discharge time; 0 to 9999.9 (sec.).
:CIResistance	Cable insulation resistance test path:
:SVOLtage<NRf>	Specify bias voltage; -1000 to 1000.
:STIME <NRf>	Specify bias time; 0 to 99999.9 (sec.).
:RVCoefficient	Resistor voltage coefficient test path:
:SVOLtage[1]<NRf>	Specify source voltage 1; -1000 to 1000.
:MDELay[1]<NRf>	Specify measure delay 1; 0 to 99999.0 (sec.).
:SVOLtage2<NRf>	Specify source voltage 2; -1000 to 1000.
:MDELay2 <NRf>	Specify measure delay 2; 0 to 99999.9 (sec.).
:SRESistivity	Surface resistivity test path:
:PDTime <NRf>	Specify pre-discharge time; 0 to 99999.9 (sec.).
:SVOLtage<NRf>	Specify bias voltage; -1000 to 1000.
:STIME <NRf>	Specify bias time; 0 to 99999.9 (sec.).
:MVOLtage<NRf>	Specify measure voltage; -1000 to 1000.
:MTIMe <NRf>	Specify measure time; 0 to 99999.9 (sec.).
:DTIMe <NRf>	Specify discharge time; 0 to 99999.9 (sec.).
:VRESistivity	Volume resistivity test path:
:PDTime <NRf>	Specify pre-discharge time; 0 to 99999.9 (sec.).
:SVOLtage<NRf>	Specify bias voltage; -1000 to 1000.
:STIME <NRf>	Specify bias time; 0 to 99999.9 (sec.).
:MVOLtage<NRf>	Specify measure voltage; -1000 to 1000.
:MTIMe <NRf>	Specify measure time; 0 to 99999.9 (sec.).
:DTIMe <NRf>	Specify discharge time; 0 to 99999.9 (sec.)
:SIResistance	Surface Insulation Resistance test path:
:SVOLtage<NRf>	Specify bias voltage; -1000 to 1000.
:STIME <NRf>	Specify bias time; 0 to 99999.9 (sec.).
:MVOLtage<NRf>	Specify measure voltage; -1000 to 1000.
:MTIMe <NRf>	Specify measure time; 0 to 99999.9 (sec.).

:SQSWeep	Square wave sweep test path:
:HLEVel <NRf>	Specify high level voltage; -1000 to 1000.
:HTIMe <NRf>	Specify high level time; 0 to 99999.9 (sec.).
:LLEVel <NRf>	Specify low level voltage; -1000 to 1000.
:LTIMe <NRf>	Specify low level time; 0 to 99999.9 (sec.).
:COUNt <NRf>	Specify number cycles.
:STSWeep	Staircase sweep test path:
:STARt <NRf>	Specify start voltage; -1000 to 1000.
:STOP <NRf>	Specify stop voltage; -1000 to 1000.
:STEP <NRf>	Specify step voltage; -1000 to 1000.
:STIME <NRf>	Specify step time; 0 to 99999.9 (sec.).

Status register

The status register structure of the Model 6517 lets you monitor and act upon numerous events that occur. Many programming decisions can be made by monitoring the Measurement Event Register and the Operation Event Register. See the User's Manual for details of the status registers.

:STATus	STATus Subsystem.
:MEASurement	Path for measurement status registers:
[:EVENt]?	Use to read the Measurement Event Register.
:OPERation	Path for operation status registers:
[:EVENt]?	Use to read the Operation Event Register.

When an event register is read, a decimal value is sent to the computer. The binary equivalent determines which bits in the register are set. For example, a decimal value of 33 indicates that bits B0 and B5 are set. An event register is cleared when it is read. Sending *CLS clears all event registers.

Some of the more useful bits of these event registers are summarized as follows:

Measurement Event Register

Bit B0 set = Reading Overflow
Bit B5 set = Reading Available
Bit B7 set = Buffer Available
Bit B8 set = Buffer Half Full
Bit B9 set = Buffer Full
Bit B14 set = V-Source Compliance

Operation Event Register

Bit B9 set = Calculating
Bit B10 set = Idle
Bit B11 set = Test Sequence Running

Program examples

All examples presume QuickBASIC version 4.5 or higher and a Keithley KPC-488.2 or CEC IEEE-488 interface card with CEC driver version 2.11 or higher, with the Model 6517 at address 27 on the IEEE-488 bus.

Changing function and range

The Model 6517 has independent controls for each of its measurement functions. This means, for example, that autorange can be turned on for volts while leaving it off for amps.

Another difference is in the parameter to the range command. In our older instruments, a single number was used to denote each range. The parameter of the SCPI `RANGe` command is given as "the maximum value to measure." The instrument interprets this parameter and goes to the appropriate range. When you query the range with `RANGe?` the instrument sends back the full-scale value of its present range.

The following example program illustrates changing function and range. It sets the range for several functions, then takes readings on each of those functions.

Note that the Model 6517 rounds the range parameter to an integer before choosing the appropriate range. Sending `VOLTage:DC:RANGe 20.45` will set the Model 6517 to the 20V range.

```
'Example program to demonstrate changing function and range,
'taking readings on various functions
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset the SENSe1 subsystem settings, along with the trigger
'model, each READ? will cause one trigger
CALL SEND(27, "*rst", status%)

'Set range for each function to measure
CALL SEND(27, "volt:dc:rang 10", status%)
CALL SEND(27, "curr:dc:rang 0.003", status%)
CALL SEND(27, "res:rang 10e6", status%)

'Switch to volts and take reading
CALL SEND(27, "func 'volt:dc';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$

'Switch to current and take reading
CALL SEND(27, "func 'curr:dc';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$

'Switch to 2-wire ohms and take reading
CALL SEND(27, "func 'res';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

One-shot triggering

Our older instruments generally have two types of triggering: one-shot and continuous. In one-shot, each activation of the selected trigger source causes one reading. In continuous, the instrument is idle until the trigger source is activated, at which time it begins taking readings at a specified rate. Typical trigger sources for non-SCPI instruments are:

- IEEE-488 talk
- IEEE-488 Group Execute Trigger (GET)
- "X" command
- External trigger (rear panel BNC)

Arming the instrument to respond to triggers is implicit in the non-SCPI instruments. Simply sending a command to a non-SCPI instrument to change any of the trigger controls causes the instrument to arm itself for triggers.

The SCPI trigger model implemented in the Model 6517 gives you:

- Explicit control over the trigger source (the `TRIGger` subsystem).
- A two-level control for arming the instrument for triggers.
- A way for completely disabling triggers.

Changing any of the settings in the `TRIGger` subsystem does not automatically arm the Model 6517 for triggers.

The following program sets up the Model 6517 to take one reading each time it receives an external trigger pulse.

```
'Example program to demonstrate one-shot external triggering
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state
CALL SEND(27, "*rst", status%)

CALL SEND(27, "trig:sour ext;coun inf", status%)

'start everything
CALL SEND(27, "init", status%)
```

After the Model 6517 receives the `INITiate` command, it stops in the `TRIGger` layer of the trigger model, waiting for a pulse on the external trigger jack. Each time a pulse arrives on the external trigger jack, the Model 6517 takes one reading. Because `TRIGger:COUNt` has been set to `INFinity`, the trigger model never exits from the `TRIGger` layer. You can send the `ABORt` command to put the trigger model in the idle state, disabling triggers until another `INITiate` command is sent.

Continuous triggering #1

The following example program sets up the Model 6517 to take readings as fast as it can once it receives an external trigger. The actual reading rate will depend upon other factors, such as A/D integration time, autorange on/off, etc.

```
'Example program to demonstrate continuous triggering
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state
CALL SEND(27, "*rst", status%)

'*RST sets TRIG:SOUR to IMM
CALL SEND(27, "arm:lay2:sour ext", status%)
CALL SEND(27, "trig:coun inf", status%)

'start everything
CALL SEND(27, "init", status%)
```

After the Model 6517 receives the `INITiate` command, it stops in `ARM:LAYer2` of the trigger model, waiting for a pulse on the external trigger jack. After the external trigger signal occurs, the Model 6517 moves to the `TRIGger` layer. Since `TRIGger:SOURce` is set to `IMMediate`, a reading is triggered immediately, with a subsequent reading triggered as soon as the previous one is finished.

Continuous triggering #2

The following example program sets up the Model 6517 to take readings continuously after an external trigger is received. The trigger rate is set to one reading every 50ms.

```
'Example program to demonstrate continuous triggering
'at a specified rate
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state
CALL SEND(27, "*rst", status%)

'*RST sets TRIG:SOUR to IMM
CALL SEND(27, "arm:lay2:sour ext", status%)
CALL SEND(27, "trig:coun inf;sour tim;tim .05", status%)

'start everything
CALL SEND(27, "init", status%)
```

After the Model 6517 receives the `INITiate` command, it stops in `ARM:LAYer2` of the trigger model, waiting for a pulse on the external trigger jack. After the external trigger signal occurs, the Model 6517 moves to the `TRIGger` layer. Since `TRIGger:SOURce` is set to `TIMer`, a reading is triggered immediately, with a subsequent reading every 50ms. Because `TRIGger:COUNt` has been set to infinity, the trigger model never exits from the `TRIGger` layer.

Generating SRQ on buffer full

When your program must wait until the Model 6517 has completed an operation, it is more efficient to program the 6517 to assert the IEEE-488 SRQ line when it is finished, rather than repeatedly serial polling the instrument. An IEEE-488 controller will typically address the instrument to talk, then unaddress it, each time it performs a serial poll. Repeated polling of the Model 6517 will generally reduce its overall reading throughput. Therefore, use the `srq%()` function call.

The Model 6517 provides a status bit for nearly every operation it performs. It can be programmed to assert the IEEE-488 SRQ line whenever a status bit becomes true or false. The IEEE-488 controller (your computer) can examine the state of the SRQ line without performing a serial poll, thereby detecting when the 6517 has completed its task without interrupting it in the process.

The following example program segment sets up the Model 6517 to assert SRQ when the reading buffer has completely filled, then arms the reading buffer, initiates readings, and waits for the Model 6517 to indicate that the buffer is full.

This is not a complete program. Not shown are the commands to configure the trigger model and the reading buffer (see the next example). The example shown here can be modified for any event in the Model 6517 status reporting system.

```
'Reset STATus subsystem (not affected by *RST)
CALL SEND(27, "stat:pres;*cls", status%)

CALL SEND(27, "stat:meas:enab 512", status%)'enable BFL
CALL SEND(27, "*sre 1", status%)'enable MSB
CALL SEND(27, "trac:feed:cont next", status%)

' Start everything
CALL SEND(27, "init", status%)

WaitSRQ:
IF (NOT(srq%)) THEN GOTO WaitSRQ
CALL SPOLL(27, poll%, status%)
IF (poll% AND 64)=0 THEN GOTO WaitSRQ
```

Notice that after the program has detected an asserted SRQ line, it serial polls the Model 6517 to determine if it is the device requesting service. This is necessary for two reasons:

- Serial polling the Model 6517 causes it to quit asserting the SRQ line.
- In test systems that have more than one IEEE-488 instrument programmed to assert SRQ, your program must determine which instrument is actually requesting service.

Once an event register has caused a service request, it cannot cause another service request until you clear it by reading it (in this case using `STATus:MEASurement[:EVENt]?`) or by sending the `*CLS` command.

Storing readings in buffer

The reading buffer in the Model 6517 is flexible and capable. It has three controls, which are found in the TRACe subsystem. There are commands to control:

- The size of the buffer (in readings).
  `TRACe:POINts <NRf>`
- Whether or not extra data is stored with each reading (e.g., channel number, timestamp). Storing extra data reduces the maximum size of the buffer.
  `TRACe:ELEMents <name>` Specify additional reading elements; TSTamp, HUMidity, CHANnel, ETEMperature, VSOurce or NONE.
- Select buffer control mode.
  `TRACe:FEED:CONTrol NEVer` immediately stop storing readings
  `TRACe:FEED:CONTrol NEXT` start now, stop when buffer is full
  `TRACe:FEED:CONTrol ALWays` start now, never stop
  `TRACe:FEED:CONTrol PRETrigger` start now, stop when pretrigger is satisfied

The following example program sets up the Model 6517 to take 20 readings as fast as it can into the buffer, then reads the data back after the buffer has filled. The readings will be stored with the timestamp, etc., but the program reads back only the reading values and timestamp.

```
'Example program to demonstrate the reading buffer
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state
CALL SEND(27, "*rst", status%)

'Reset STATus subsystem (not affected by *RST)
CALL SEND(27, "stat:pres;*cls", status%)
CALL SEND(27, "stat:meas:enab 512", status%)'enable BFL
CALL SEND(27, "*sre 1", status%)'enable MSB
CALL SEND(27, "trig:coun 20", status%)

'TRACe subsystem is not affected by *RST
CALL SEND(27, "trac:poin 20;elem none", status%)
CALL SEND(27, "trac:feed:cont next", status%)

'Start everything
CALL SEND(27, "init", status%)

'Initialize reading$ while the 6517 is busy taking readings
reading$ = SPACE$(4000)

WaitSRQ:
IF (NOT(srq%) THEN GOTO WaitSRQ
CALL SPOLL(27, poll%, status%)
IF (poll% AND 64)=0 THEN GOTO WaitSRQ

CALL SEND(27, "trac:data?", status%)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

Taking readings with the scanner card

The Models 6521 and 6522 are optional 10-channel scanner cards for the Model 6517 Multimeter. Only one channel can be closed at a time. If you close a channel while another is already closed, the first one opens with break-before-make operation.

You can use the scanner card two ways. One is to issue a command to close a particular channel before sending other commands to take readings. The other way is to program the scan list, and let the meter take care of closing a channel before taking a reading.

The following example program measures volts on channel 1, amps on channel 2, and resistance on channel 3, using the `ROUTe:CLOSe` command.

```
'Example program to demonstrate taking readings on different
'scanner channels
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state, set function to volts
CALL SEND(27, "*rst", status%)

'Close channel 1, take voltage reading
CALL SEND(27, "rout:clos (@1);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$

'Close channel 2, take current reading
CALL SEND(27, "func 'curr:dc'", status%)
CALL SEND(27, "rout:clos (@2);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$

'Close channel 3, take ohms reading
CALL SEND(27, "func 'res'", status%)
CALL SEND(27, "rout:clos (@3);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

The following example program sets up the Model 6517 using a scan list to measure DC voltage on channels 1, 2 and 3. The meter takes ten sets of readings, with each set spaced 15 seconds apart, and each of the three readings in each group taken as fast as possible. The Model 6517 stores the readings in the buffer, and asserts SRQ when the buffer is full. The program waits for the SRQ, then reads the readings from the buffer.

```
'Example program to demonstrate using the scan list
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card

'Edit the following line to where the QuickBASIC
'libraries are on your computer
'$INCLUDE: 'c:\qb45\ieeeqb.bi'

'Initialize the interface as address 21
CALL initialize(21, 0)

'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state, set function to DCV
CALL SEND(27, "*rst", status%)

'Reset STATus subsystem (not affected by *RST)
CALL SEND(27, "stat:pres;*cls", status%)

CALL SEND(27, "stat:meas:enab 512", status%)'enable BFL
CALL SEND(27, "*sre 1", status%)'enable MSB
```

```
'*RST sets TRIG:SOUR to IMM
CALL SEND(27, "trig:coun 3", status%)
CALL SEND(27, "arm:lay2:sour tim;tim 15", status%)
CALL SEND(27, "arm:lay2:coun 10", status%)

'TRACe subsystem is not affected by *RST
CALL SEND(27, "trac:poin 30;elem none", status%)
CALL SEND(27, "trac:feed sens1;feed:coun next", status%)
' now the buffer is armed

CALL SEND(27, "rout:scan (@1:3)", status%)
CALL SEND(27, "rout:lsel int", status%)

'Start everything
CALL SEND(27, "init", status%)

'Initialize reading$ while the 6517 is busy taking readings
reading$ = SPACE$(2500)

WaitSRQ:
IF (NOT(srq%()) THEN GOTO WaitSRQ
CALL SPOLL(27, poll%, status%)
IF (poll% AND 64)=0 THEN GOTO WaitSRQ

CALL SEND(27, "form:elem read,time,chan", status%)
CALL SEND(27, "trac:data?, status%)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

Test Sequence — staircase sweep

The following program performs a staircase sweep. Using the source voltage measure current (FVMI) method, this test will measure the current through a DUT (see Figure 16) at eleven voltage steps (0V through 10V). The eleven readings are stored in the buffer and displayed on the computer CRT at the conclusion of the test.

```
'Quick Basic 4.5, KPC-488.2/CEC card
'
'$INCLUDE: 'ieeeqb.bi'

CALL initialize(21, 0)
CLS
CALL send(27, "*rst", status%)
CALL send(27, "*CLS", status%)
CALL spoll(27, KIspoll%, status%)

'Configure status model to SRQ on Buffer Full:

CALL send(27, "stat:meas:enab 512", status%)
CALL SEND(27, "*sre 1", status%)

'Select autoranging amps:

CALL send(27, ":SENS:FUNC 'CURR'", status%)
CALL send(27, ":SENS:CURR:RANG:AUTO ON", status%)

'Configure Staircase Sweep from 0V to 10V in 1V steps:

CALL send(27, ":TSEQ:TYPE STSW", status%)
CALL send(27, ":TSEQ:STSW:STAR 0", status%)
CALL send(27, ":TSEQ:STSW:STOP 10", status%)
CALL send(27, ":TSEQ:STSW:STEP 1", status%)
CALL send(27, ":TSEQ:STSW:STIM 0.3", status%)
CALL send(27, ":TSEQ:TSO imm", status%)

'Wait for commands to complete processing:

DATA1$ = SPACE$(600)
CALL send(27, "*OPC?", status%)
CALL enter(DATA1$, length%, 27, status%)

' Start Test Sequence:

CALL send(27, ":TSEQ:ARM", status%)

'Wait for SRQ (buffer full):

WaitSRQ
IF (NOT (srq%)) THEN GOTO WaitSRQ
CALL spoll(27, poll%, status%)
If (poll% AND 64) = 0 THEN GOTO WaitSRQ

'Dump buffer readings to computer CRT:

CALL send(27, ":TRACE:DATA?", status%)
CALL enter(DATA1$, length%, 27, status%)
A = 1
FOR I = 1 TO 11
  r$ = MID$(DATA!$, A, 13)
  PRINT r$
  A = A + 14
NEXT I

END
```

4
Specifications

VOLTS

RANGE	5½ DIGIT RESOLUTION	ACCURACY (1 Year)[1] 18°–28°C ±(%rdg+counts)	TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C ±(%rdg+counts)/°C
2 V	10 µV	0.025 + 4	0.003 + 2
20 V	100 µV	0.025 + 3	0.002 + 1
200 V	1 mV	0.06 + 3	0.002 + 1

Note:

[1]When properly zeroed, 5½ digit, 1 PLC (power line cycle), median filter on, digital filter = 10 readings.

NMRR: 60dB on 2V, 20V, >55dB on 200V, at 50Hz or 60Hz ±0.1%.

CMRR: >120dB at DC, 50Hz or 60Hz.

INPUT IMPEDANCE: >200TΩ in parallel with 20pF, < 2pF guarded (10MΩ with zero check on).

SMALL SIGNAL BANDWIDTH AT PREAMP OUTPUT: Typically 100kHz (–3dB).

AMPS

RANGE	5½ DIGIT RESOLUTION	ACCURACY (1 Year)[1] 18°–28°C ±(%rdg+counts)	TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C ±(%rdg+counts)/°C
20 pA	100 aA[2]	1 + 30	0.1 + 5
200 pA	1 fA[2]	1 + 5	0.1 + 1
2 nA	10 fA	0.2 + 30	0.1 + 2
20 nA	100 fA	0.2 + 5	0.03 + 1
200 nA	1 pA	0.2 + 5	0.03 + 1
2 µA	10 pA	0.1 + 10	0.005 + 2
20 µA	100 pA	0.1 + 5	0.005 + 1
200 µA	1 nA	0.1 + 5	0.005 + 1
2 mA	10 nA	0.1 + 10	0.008 + 2
20 mA	100 nA	0.1 + 5	0.008 + 1

Note:

[1]When properly zeroed, 5½ digit, 1 PLC (power line cycle), median filter on, digital filter = 10 readings.

[2]aA = 10^{-18}A, fA = 10^{-15}A.

INPUT BIAS CURRENT: <3fA at T_{CAL}. Temperature coefficient = 0.5fA/°C.

INPUT BIAS CURRENT NOISE: <750aA p-p (capped input), 0.1Hz to 10Hz bandwidth, damping on. Digital filter = 40 readings.

INPUT VOLTAGE BURDEN at T_{CAL} ±1°C:
<20µV on 20pA, 2nA, 20nA, 2µA, 20µA ranges.
<100µV on 200pA, 200nA, 200µA ranges.
<2mV on 2mA range.
<4mV on 20mA range.

TEMPERATURE COEFFICIENT OF INPUT VOLTAGE BURDEN: <10µV/°C on pA, nA, µA ranges.

PREAMP SETTLING TIME (to 10% of final value): 2.5s typical on pA ranges, damping off, 4s typical on pA ranges damping on, 9ms on nA ranges, 1ms on µA and mA ranges.

NMRR: >95dB on pA, 60dB on nA, µA, and mA ranges at 50Hz or 60Hz ±0.1%.

COULOMBS

RANGE	5½ DIGIT RESOLUTION	ACCURACY (1 Year)[1,2] 18°–28°C ±(%rdg+counts)	TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C ±(%rdg+counts)/°C
2 nC	10 fC	0.4 + 5	0.04 + 3
20 nC	100 fC	0.4 + 5	0.04 + 1
200 nC	1 pC	0.4 + 5	0.04 + 1
2 µC	10 pC	0.4 + 5	0.04 + 1

Note:

[1]Charge acquisition time must be <1000s, derate 1% for each additional 10,000s.

[2]When properly zeroed, 5½ digit, 1 PLC (power line cycle), median filter on, digital filter = 10 readings.

INPUT BIAS CURRENT: <4fA at T_{CAL}. Temperature coefficient = 0.5fA/°C.

OHMS: Normal Method

RANGE	5½ DIGIT RESOLUTION	ACCURACY[1] (10–100% Range) 18°–28°C (1 Yr.) ±(% rdg+counts)	TEMPERATURE COEFFICIENT (10–100% Range) 0°–18°C & 28°–50°C ±(% rdg+counts)	TEST VOLTS	AMPS RANGE
2 MΩ	10 Ω	0.125 + 1	0.01 + 1	40 V	200 µA
20 MΩ	100 Ω	0.125 + 1	0.01 + 1	40 V	20 µA
200 MΩ	1 kΩ	0.15 + 1	0.015 + 1	40 V	2 µA
2 GΩ	10 kΩ	0.225 + 1	0.035 + 1	40 V	200 nA
20 GΩ	100 kΩ	0.225 + 1	0.035 + 1	40 V	20 nA
200 GΩ	1 MΩ	0.35 + 1	0.110 + 1	40 V	2 nA
2 TΩ	10 MΩ	0.35 + 1	0.110 + 1	400 V	2 nA
20 TΩ	100 MΩ	1.025 + 1	0.105 + 1	400 V	200 pA
200 TΩ	1 GΩ	1.15 + 1	0.125 + 1	400 V	20 pA

Note:

[1]Specifications are for auto V-source ohms, when properly zeroed, 5½ digit, 1 PLC, median filter on, digital filter = 10 readings. If user selectable voltage is required, use manual mode. Manual mode displays resistance (up to $10^{18}\Omega$) calculated from measured current. Accuracy is equal to accuracy of V-source plus accuracy of selected Amps range.

PREAMP SETTLING TIME: Add voltage source settling time to preamp settling time in Amps specification.

OHMS: Alternating Polarity Method

Using Keithley 8002A or 8009 fixture

REPEATABILITY: $\Delta I_{BG} * R/V_{ALT} + 0.1\%$ (1σ) (instrument temp. constant ±1°C).

ACCURACY: $(V_{SRC}Err + I_{MEAS}Err * R)/V_{ALT}$

where: ΔI_{BG} is a measured, typical background current noise from the sample and fixture over the measurement time programmed, under normal measurement conditions (1 PLC, same range, filters off, etc.)

V_{ALT} is the alternating polarity voltage used

$V_{SRC}Err$ is the accuracy (in volts) of the voltage source using V_{ALT} as the setting

$I_{MEAS}Err$ is the accuracy (in amps) of the ammeter using V_{ALT}/R as the rdg

With conditions: $\Delta I_{BG} * R/V_{ALT} < 10\%$; capacitance of sample <10nF in parallel with measured R

Note that the measured resistance is affected by the series and parallel resistance of the test fixture.

VOLTAGE SOURCE

RANGE	5½ DIGIT RESOLUTION	ACCURACY (1 Year)[1] 18°–28°C ±(% setting + offset)	TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C ±(% setting+offset)/°C
100 V	5 mV	0.15 + 10 mV	0.005 + 1 mV
1000 V	50 mV	0.15 + 100 mV	0.005 + 10 mV

MAXIMUM OUTPUT CURRENT:
±10mA; active current limit at <11.5mA for 100V range.
±1mA; active current limit at <1.15mA for 1000V range.

SETTLING TIME:
<8ms to rated accuracy for 100V range.
<50ms to rated accuracy for 1000V range.

NOISE:
<150µV p-p from 0.1Hz to 10Hz for 100V range.
<1.5mV p-p from 0.1Hz to 10Hz for 1000V range.

TEMPERATURE (THERMOCOUPLE)

THERMOCOUPLE TYPE	RANGE	ACCURACY (1 Year)[1] 18°–28°C ±(% rdg + °C)
K	–25°C to 150°C	± (0.3% ± 1.5°C)

Note: [1]Excluding probe errors, T_{CAL} ± 5°C, 1 PLC integration time.

HUMIDITY

RANGE	ACCURACY (1 Year)[1] 18°–28°C ±(% rdg + % RH)
0–100%	± (0.3% +0.5)

Note:

[1]Humidity probe accuracy must be added. This is ±3% RH, for Model 6517-RH, up to 65°C probe environment, not to exceed 85°C.

IEEE-488 BUS IMPLEMENTATION

MULTILINE COMMANDS: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.

IMPLEMENTATION: SCPI (IEEE-488.2, SCPI-1994.0); DDC (IEEE-488.1).

UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.

INTERFACE FUNCTIONS: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

PROGRAMMABLE PARAMETERS: Function, Range, Zero Check, Zero Suppress, EOI (DDC mode only), Trigger, Terminator (DDC mode only), 100-Reading Storage (DDC mode), 15706 Max. Reading Storage (SCPI mode), Calibration (SCPI mode only), V-Source Output, Display Format, SRQ, Status (including V-Source I-Limit), Output Format, Guard.

ADDRESS MODES: TALK ONLY and ADDRESSABLE.

TRIGGER TO READING DONE: 150ms typical, with external trigger.

RS-232 IMPLEMENTATION:
Supports: SCPI 1994.0.
Baud Rates: 300, 600, 1200, 2400, 4800, 9600, 19.2k.
Protocols: Xon/Xoff, 7 or 8 bit ASCII, parity-odd/even/none.
Connector: DB-9 TXD/RXD/GND.

GENERAL

DISPLAY: 6½-digit vacuum fluorescent multiline.

OVERRANGE INDICATION: Display reads "OVERFLOW".

RANGING: Automatic or manual.

CONVERSION TIME: Selectable 0.01 PLC to 10 PLC.

PROGRAMS: Provide front panel access to IEEE address, choice of engineering units or scientific notation, and digital calibration.

MAXIMUM INPUT: 250V peak, DC to 60Hz sine wave; 10s per minute maximum on mA ranges.

MAXIMUM COMMON MODE VOLTAGE (DC to 60Hz sine wave): Electrometer, 500V peak; V Source, 750V peak.

ISOLATION (Meter COMMON to chassis): Typically $10^{10}\Omega$ in parallel with 500pF.

INPUT CONNECTOR: Three lug triaxial on rear panel.

2V ANALOG OUTPUT: 2V for full range input. Non-inverting in Volts mode. Output impedance 10kΩ.

PREAMP OUTPUT: Provides a guard output for Volts measurements. Can be used as an inverting output or with external feedback in Amps and Coulombs modes.

EXTERNAL TRIGGER: TTL compatible External Trigger and Electrometer Complete.

GUARD: Switchable voltage guard available.

DIGITAL I/O AND TRIGGER LINE: Available, see manual for usage.

EMI/RFI: Meets VDE-0871 and FCC Class B limits.

TEST SEQUENCES: Alternating Polarity Hi-R, Device-Characterization (Diode, Capacitor, Cable, Resistor), Resistivity, Surface-Insulation-Resistance, and Sweep.

READING STORAGE: 100 readings (DDC mode), 15706 max. readings (SCPI mode).

READING RATE:

To internal buffer	125	readings/second[1]
To IEEE-488 bus	115	readings/second[1,3]
To front panel	15	readings/second[2]
Bus transfer	2500	readings/second[3]

Note:

[1] 0.01 PLC, digital filters off, front panel off, temperature + RH off.

[2] 1.00 PLC, digital filters off, temperature + RH off.

[3] Binary transfer mode.

DIGITAL FILTER: Median and averaging.

ENVIRONMENT:

Operating: 0°–50°C; relative humidity 70% non-condensing, up to 35°C.
Storage: –25° to +65°C.

WARM-UP: 1 hour to rated accuracy (see manual for recommended procedure).

POWER: 105–125V or 210–250V (external switch selected), 90–110V (internal modification required), 50–60Hz, 50VA.

PHYSICAL:

Case Dimensions: 90mm high × 214mm wide × 369mm deep (3½ in. × 8½ in. × 14½ in.).

Working Dimensions: From front of case to rear including power cord and IEEE-488 connector: 15.5 inches.

Net Weight: <4.6 kg (<10.1 lbs).

Shipping Weight: <9.5 kg (<21 lbs).

ACCESSORIES SUPPLIED:

Model 237-ALG-2	Low Noise Triax Cable, 3-slot Triax to Alligator Clips 2m (6.6 ft)
Model 8607	Safety High Voltage Dual Test Leads
Model 6517-TP	Thermocouple Input Lead
Model CS-459	Interlock Connector

Specifications subject to change without notice.

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Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

❑ Intermittent ❑ Analog output follows display ❑ Particular range or function bad; specify

_____

❑ IEEE failure ❑ Obvious problem on power-up ❑ Batteries and fuses are OK

❑ Front panel operational ❑ All ranges or functions are bad ❑ Checked all cables

Display or output (check one)

❑ Drifts ❑ Unable to zero ❑ Unstable

❑ Overload ❑ Will not read applied input

❑ Calibration only ❑ Certificate of calibration required ❑ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)_____

_____

What power line voltage is used?_____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

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